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(54) **Image processing apparatus and method**

Gerät und Verfahren zur Bildverarbeitung

Appareil et méthode de traitement d'image

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an image processing apparatus and, more particularly, to an image processing apparatus, which can adopt an automatic density conversion method for original information for faithfully reproducing an original image (to be referred to as "AE processing" hereinafter).

2. Description of the Related Art

[0002] In a conventional image processing apparatus, an original image is read by an image input device, and the read image data is converted to an electrical signal. The electrical signal is subjected to image processing, and thereafter, the processed signal is output as an image by an output device such as a laser beam printer.

[0003] Such an image processing apparatus has a function of selecting an original mode selection button and a density selection button from an operation unit according to the type or density of an original, as its characteristic feature.

[0004] However, designation (selection) from the operation unit makes it very difficult to obtain a copy having a desired recording density and image quality although a density and the like can be desirably selected.

[0005] For this reason, selection of buttons on the operation unit and recording must be repeated several times. Therefore, wasteful copying operations are undesirably performed, and a time required until a desired copy is obtained is prolonged.

[0006] When the density of a character portion on a light character original is to be increased, a background image is undesirably fogged, resulting in poor appearance.

[0007] The present invention is concerned with providing an image processing apparatus, which can eliminate the conventional drawbacks.

[0008] In one embodiment the present invention provides an image processing apparatus, which can automatically discriminate the density or type of an original without manually selecting a density or original type, and can facilitate a copying operation.

[0009] Additionally the present invention can provide an image processing apparatus, which can facilitate a copying operation, and can shorten a copying time.

[0010] In a preferred embodiment of the present invention there is provided an image processing apparatus, which does not record an unnecessary portion of an original, and can record an original image including a light information portion while emphasizing the information portion to be darker.

[0011] The present invention is also concerned with providing an image processing apparatus, which can record an original image having gradation characteristics without impairing the gradation characteristics.

[0012] Additionally the invention is concerned with providing an image processing apparatus, which can obtain a copy suffering from less blurring of characters or deterioration of image quality by executing optical gradation correction of even a copied original obtained after repetitive copying operations.

[0013] An embodiment of the present invention can provide an image processing apparatus, which can simplify a copying operation, and can obtain an optical copy output according to the density or type of an original even by the simplified copying operation.

[0014] European Patent Application No. EP-A-0,435,658 discloses a digital copier in which colour histograms are generated from the image data and classified by shape. Signal processing is carried out in accordance with the clarification.

[0015] United States Patent Specification No. US-A-4903145 discloses an image reading processing apparatus having histogram calculators for correcting the density of image data generated by the apparatus reading an original image.

[0016] From a first aspect the present invention provides an image processing apparatus as set out in claim 1.

[0017] From a second aspect the present invention provides an image processing method as set out in claim 14.

[0018] Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a sectional view showing a structure of an image processing apparatus according to the first embodiment

of the present invention;
Fig. 2 is a block diagram showing an arrangement of a controller section CONT shown in Fig. 1;
Fig. 3 is a block diagram showing an arrangement of an image signal control unit shown in Fig. 2;
Fig. 4 is a block diagram showing an arrangement of a histogram forming unit 38;
Fig. 5 is a timing chart showing an operation state upon formation of a histogram;
Figs. 6A and 6B are timing charts showing read and write timings of an internal memory of the histogram forming unit;
Fig. 7A is a view showing a histogram formation range upon formation of a histogram, and Fig. 7B is a view for explaining a sampling interval;
Fig. 8 is a flow chart showing an operation sequence of AE processing in the first embodiment of the present invention;
Fig. 9 is a view showing a histogram of a typical original;
Fig. 10 is a flow chart for explaining an operation for obtaining feature points from a histogram;
Fig. 11 is a flow chart for explaining an operation for discriminating an original type;
Fig. 12 is a graph showing a histogram of a normal image type, and its conversion table characteristics;
Fig. 13 is a graph showing a histogram of a reversal image type, and its conversion table characteristics;
Fig. 14 is a graph showing a histogram of a gradation image type, and its conversion table characteristics;
Fig. 15A is a graph showing the gradation characteristics of a printer, and Fig. 15B is a graph showing the conversion table characteristics thereof;
Fig. 16 is a flow chart for explaining an operation for discriminating an original type according to the second embodiment of the present invention;
Fig. 17 is a graph showing a normal image type original in the second embodiment;
Fig. 18 is a graph showing a reversal image type original in the second embodiment;
Fig. 19 is a graph showing a gradation image type original in the second embodiment;
Fig. 20 is a flow chart showing a subroutine for obtaining "white" level of the normal image type in the second embodiment;
Fig. 21 is a flow chart showing a subroutine for obtaining "black" level of the normal image type in the second embodiment;
Fig. 22 is a flow chart showing a subroutine for obtaining "black" level of the reversal image type in the second embodiment;
Fig. 23 is a flow chart showing a subroutine for obtaining "white" level of the reversal image type in the second embodiment;
Fig. 24 is a block diagram showing an arrangement of a histogram forming unit according to the third embodiment of the present invention; and
Figs. 25A and 25B are graphs showing input/output characteristics obtained in consideration of an offset in conversion tables.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

<First Embodiment>

[0020] Fig. 1 is a side sectional view showing an arrangement of an image copying apparatus according to the first embodiment of the present invention.

[0021] In Fig. 1, reference numeral 1 denotes an original feeder as an original feeding mechanism for feeding stacked originals one by one or feeding two consecutive originals to a predetermined position on an original table glass surface 2. Reference numeral 3 denotes a scanner comprising, e.g., a lamp, a scanning mirror 5, and the like. When an original is placed on the original table glass surface 2 by the original feeder 1, the main body of the scanner 3 is reciprocally scanned in predetermined directions, and light reflected by the original is color-separated by RGB color separation filters (not shown) through scanning mirrors 5 to 7 and a lens 8, thus forming color-separated images on an image sensor section 9.

[0022] Reference numeral 10 denotes an exposure control section comprising a laser scanner. The exposure control section 10 radiates a light beam modulated on the basis of image data output from an image signal control unit 23 (see Fig. 2; to be described later) of a controller section CONT onto a photosensitive body 11. Reference numerals 12 and 13 denote developing devices each for visualizing an electrostatic latent image formed on the photosensitive body 11 using a developing agent (toner) of a predetermined color. Reference numerals 14 and 15 denote transfer sheet stacking sections each for stacking and storing recording media having a standard size. Each recording medium is fed to a registration position by driving a paper feed roller, and is re-fed in synchronism with an image leading end timing of an image to be formed on the photosensitive body 11.

[0023] Reference numeral 16 denotes a transfer/separation charger for transferring a toner image developed on the photosensitive body 11 onto a transfer sheet, and separating the transfer sheet from the photosensitive body 11. The separated sheet is conveyed to a fixing section 17 via a conveyor belt, and the transferred image on the sheet is fixed by the fixing section 17. Reference numeral 18 denotes discharge rollers for discharging and stacking transfer sheets, for which image formation has been completed, onto a tray 20. Reference numeral 19 denotes a discharge sensor. Reference numeral 21 denotes a direction flapper, for switching the convey direction of the transfer sheet, for which image formation has been completed, between a discharge port direction and an internal convey path direction so as to prepare for a multiple/double-sided image formation process.

[0024] Image formation onto a recording medium will be described below. An image signal input to the image reader section 9, i.e., an input signal from a reader 22 (to be described later) is processed by an image signal control circuit 23, which is controlled by a CPU 25, and the processed signal is supplied to a printer 24. The signal input to the printer 24 is converted into a light signal by the exposure control section 10, and the light signal is radiated onto the photosensitive body 11 according to an image signal. A latent image formed on the photosensitive body 11 by the radiated light is developed by the developing device 12 or 13. A transfer sheet is conveyed from the transfer sheet stacking unit 14 or 15 in synchronism with the latent image timing, and the developed image is transferred onto the sheet by the transfer/separation charger 16. The transferred image is fixed on the transfer sheet by the fixing section 17, and the transfer sheet is then discharged outside the apparatus by the discharge rollers 18.

[0025] In a double-sided recording mode, after the transfer sheet passes the discharge sensor 19, the discharge rollers 18 are rotated in a direction opposite to the paper discharge direction. At the same time, the direction flapper 21 is moved upward to store the copied transfer sheet in an intermediate tray 24 via convey paths 22 and 23. In a rear-surface recording operation to be executed next, the transfer sheet stored in the intermediate tray 24 is fed, and an image is transferred onto the rear surface of the sheet.

[0026] In a multiple recording mode, the direction flapper 21 is moved upward to store the copied transfer sheet in the intermediate tray 24 via the convey paths 22 and 23. In the multiple recording operation to be executed next, the transfer sheet stored in the intermediate tray 24 is fed, and is subjected to a multiple transfer process.

[0027] Fig. 2 is a block diagram showing an internal arrangement of the controller section CONT shown in Fig. 1. Referring to Fig. 2, reference numeral 1025 denotes a CPU circuit unit, which incorporates a ROM 1026 and a RAM 1027, and systematically controls the respective units on the basis of a control program stored in the ROM 1026.

[0028] Reference numeral 1021 denotes an original (automatic) feeder control unit, which controls, e.g., to feed stacked originals one by one or to feed two consecutive originals to the predetermined position on the original table glass surface 2.

[0029] Reference numeral 1022 denotes an image reader control unit which comprises, e.g., the image sensor section 9, and outputs analog image signals obtained by photoelectrically converting light signals separated by RGB color separation filters (not shown) to an image signal control unit 1023. Reference numeral 1024 denotes a printer control unit for driving the exposure control section 10 on the basis of a video signal output from the image signal control unit 1023 to radiate a light beam onto the photosensitive body 11. Reference numeral 1028 denotes an operation unit, which has an operation panel having keys for setting modes necessary for image formation, displays, and the like.

[0030] Fig. 3 is a block diagram showing an internal arrangement of the image signal control unit 1023 of this embodiment. In Fig. 3, reference numeral 30 denotes an A/D converter; 31, a black correction/white correction unit; 32, an ND signal generation unit; 33, a color detection unit; 34, a variable magnification unit; 35, an image processing unit; 36, a density correction unit; 37, a marker region detection unit; and 38, a histogram forming unit.

[0031] An operation of the arrangement described above will be described below.

[0032] Analog image signals converted to R, G, and B electrical signals by the image reader control unit 1022 are converted into digital signals (8-bit signals in this embodiment) by the A/D converter 30.

[0033] The digital signals are subjected to black level correction and white level correction (shading correction) by the black correction/white correction unit 31. Thereafter, the R, G, and B signals are input to the ND signal generation unit 32 and the color detection unit 33.

[0034] The ND signal generation unit 32 adds the R, G, and B signals, and divides the sum by 3 to output a luminance signal Dout given by the following equation (1):

$$\mathrm{Dout} = (\mathrm{Rin} + \mathrm{Gin} + \mathrm{Bin})/3 \qquad (1)$$

[0035] The color detection unit 33 classifies the input R, G, and B signals to one of, e.g., red, green, blue, pink, yellow, orange (these three colors are line marker colors), white, and black on the basis of the ratio of the R, G, and B signals, and outputs a 3-bit chrominance signal Cout.

[0036] The luminance signal Dout and the chrominance signal Cout are subjected to variable magnification processing in the main scan direction (the line direction of a CCD) or image move processing by the variable magnification

unit 34, and the processed signals are input to the image processing unit 35.

[0037] The image processing unit 35 executes halftone dot screen processing, pattern conversion processing for converting chrominance information into a monochrome pattern, masking processing, trimming processing, black/white reversal processing, and the like.

[0038] Thereafter, the density correction unit 36 executes luminance-density conversion and density correction for a printer, and the processed signals are supplied to the printer control unit 1024 for the printer.

[0039] The luminance signal Dout and the chrominance signal Cout respectively output from the ND signal generation unit 32 and the color detection unit 33 are input to the histogram forming unit 38, and a histogram is formed. This histogram is added with chrominance signal information, as needed.

[0040] The chrominance signal Cout is also input to the marker region detection unit 37. The marker region detection unit 37 detects a signal of a region designated on an original using a line marker on the basis of the chrominance signal Cout, and supplies it as a processing region signal to the image processing unit 35. The image processing unit 35 executes black/white reversal processing, halftone dot screen processing, and the like inside or outside the designated region according to the processing region signal.

[0041] Fig. 4 is a block diagram showing an arrangement of the histogram forming unit 38 according to this embodiment.

[0042] The arrangement shown in Fig. 4 is entirely controlled by an internal timing generator on the basis of sync signals HSYNC, HVALiD, and CLK. This arrangement can also be controlled by signals from the CPU circuit unit 1025.

[0043] Fig. 5 is a timing chart of the histogram forming unit 38 based on the sync signal HSYNC. In Fig. 5, a control signal CPAL from the CPU circuit unit 1025 is synchronized with the signal HSYNC to generate a TSEL signal.

[0044] During an L-level period of the TSEL signal, the luminance signal Dout from the ND signal generation unit 32 is written in a memory (to be described later).

[0045] During an H-level period of the TSEL signal, the CPU circuit unit 1025 reads out the content of the memory, and a histogram for one line is formed in an internal RAM of a CPU.

[0046] Referring to Fig. 4, reference numeral 50 denotes a programmable memory such as a RAM, which has a capacity capable of storing image information for one line read by the image reader section 1022. Reference numeral 51 denotes an output-controllable buffer, which supplies the luminance signal Dout from the ND signal generation unit 32 to the data input terminal of the memory 50 when the TSEL signal is at L level. Reference numerals 52 and 53 denote data selectors each for selecting control signals (address, $\overline{OE}$, $\overline{WR}$, and $\overline{CS}$) generated by a timing generator 54, and control signals (address bus, $\overline{MRD}$, $\overline{MWR}$, and $\overline{MCS}$) from the CPU according to the TSEL signal, and supplying the selected signal to the memory 50.

[0047] The timing generator 54 generates control signals on the basis of the sync signals CLK, HVALiD, and HSYNC.

[0048] Reference numeral 55 denotes an output-controllable buffer, which is output-controlled by a $\overline{TSEL}$ signal and an $\overline{MWR}$ signal input to a negative logic input NAND gate 57. When the output from the NAND gate 57 is at L level, the buffer 55 sends data from a CPU bus to the data input terminal of the memory 50. Reference numeral 56 denotes an output-controllable buffer, which is output-controlled by an $\overline{MCS}$ signal and an $\overline{MRD}$ signal input to a negative logic input NAND gate 58. When the output from the NAND gate 58 is at L level, the buffer 56 sends data read out from the memory 50 onto the CPU data bus.

[0049] Reference numeral 59 denotes a D-type flip-flop, which synchronizes the control signal CPAL from the CPU circuit unit 1025 with the one-line sync signal HSYNC to generate the TSEL signal.

[0050] Figs. 6A and 6B are timing charts showing read and write timings of the internal memory 50 of the histogram forming unit 38 in this embodiment.

[0051] Fig. 6A shows the memory write timing during a write period of the luminance signal to the memory in Fig. 5, and this timing is defined by the timing generator 54.

[0052] In response to the signal HSYNC, an internal address counter (not shown) of the timing generator 54 is initialized and an ADRS signal is reset to "0". The address counter is an up counter, which counts the sync signal CLK for one pixel of image information and generates the ADRS signal when the HVALiD signal is at H level. According to this ADRS signal, the luminance signal is written at a predetermined address ADRS when a memory write signal $\overline{WR}$ goes from L level to H level.

[0053] Fig. 6B shows the memory read timing from the CPU circuit unit 1025 during a memory read & histogram forming period in the CPU circuit unit 1025 in Fig. 5. When a memory selection signal $\overline{MCS}$ from the CPU circuit unit 1025 is at L level, a read access to the memory is enabled. An address signal output from the CPU circuit unit 1025 onto an address bus is supplied to the address input terminal of the memory 50. When a CPU memory read signal $\overline{MRS}$ is at L level, the memory content is read out from the memory, and is output onto the CPU data bus. The timing signals (Figs. 6A and 6B) to be supplied to the memory 50 are selected according to the TSEL signal.

[0054] In this embodiment, image processing is executed using a first mode for obtaining a table on the basis of electrical signals of an original image obtained by a pre-scan operation, and a second mode for obtaining reproduction signals of the original image by a main scan operation according to the table obtained in the first mode.

First Mode

[0055] Fig. 8 is a flow chart of AE processing in this embodiment.

[0056] In steps S1 and S2, a histogram is formed, and feature points of the histogram are detected. As will be described later, in step S3, an original type is discriminated, and a conversion table corresponding to the discriminated type is formed. Finally, in step S4, a γ table including the formed conversion table is formed, and is written in the density correction unit 36 of the image signal control unit 1023. The details of processing in steps S1 to S4 will be described below.

[Method of Forming Histogram (S1)]

[0057] Formation of a histogram is performed in the following order.

[0058] Prior to reading of an original image, a pre-scan operation is performed to input a luminance signal and to form a histogram. In this case, all pixels may be input to sample luminance signals. However, pixels are coarsely thinned out and sampled so as not to disturb the feature of a histogram of an original image. In this case, the sampling interval is, e.g., about 1 mm.

(1) Input of Luminance Signals For One Line

[0059] All pixel data for one line are written in the memory 50 during the L-level period of the TSEL signal in Fig. 5. When the TSEL signal is at L level, the buffer 51 is set in an output enable state, and luminance signals Dout from the ND signal generation unit 32 are supplied to the memory 50. In the data selectors 52 and 53, their select terminals S are set at L level, A input terminals are selected, and the control signals (address, $\overline{OE}$, $\overline{WR}$, and $\overline{CS}$) generated by the timing generator 54 are supplied to the memory 50. The write timing is as shown in Fig. 6A.

(2) Memory Read Access by CPU Circuit Unit 1025

[0060] The memory content written in (1) is read out by the CPU during the H-level period of the TSEL signal in Fig. 5.

[0061] The TSEL signal is generated based on the CPAL signal output from the CPU circuit unit 1025, and the CPU circuit unit 1025 reads out data for one immediately preceding line from the memory when the TSEL signal goes to H level.

[0062] When the TSEL signal is at H level, the buffer 51 is set in an output disable state, and its output has a high impedance. In the data selectors 52 and 53, their select terminals S are set at H level, B input terminals are selected, and the control signals (address bus, $\overline{MRD}$, $\overline{MWR}$, and $\overline{MCS}$) from the CPU circuit unit 1025 are supplied to the memory 50. The buffer 56 is set in an output enable state when $\overline{MCS}$ and $\overline{MRD}$ signals from the CPU circuit unit 1025 simultaneously go to L level, and outputs the data read out from the memory onto the data bus of the CPU circuit unit 1025. The buffer 55 is set in an output enable state when $\overline{TSEL}$ and $\overline{MWR}$ signals simultaneously go to L level, and supplies data from the CPU circuit unit 1025 to the memory 50.

[0063] If the normal reading resolution is 400 dots/inch, since 1 mm is defined by about 16 dots, data can be read out by the CPU circuit unit 1025 at every 16 addresses (main scan direction). For example, the addresses are changed like 1, 17, 33, 49, and 65. The read timing is as shown in Fig. 6B.

(3) Formation of Histogram

[0064] A histogram is formed by adding the frequencies of levels of the luminance signals read out from the memory in units of levels. Sampling data for one line are processed, and the processing result is stored in the internal memory of the CPU circuit unit 1025.

[0065] In this embodiment, since the luminance signal is an 8-bit signal, the frequencies in a range from 0 to 255 levels are added. If one level is expressed by 16 bits, the maximum frequency corresponding to about 65,000 data can be stored. More specifically, in order to store histogram data, a memory capacity of 256 words (512 bytes) is required.

(4) Operation for Repeating Processing Operations (1) and (2) within Predetermined Range

[0066] Since the sampling interval in the sub-scan direction is also 1 mm, if the reading resolution is 400 dots/inch, luminance signals need only be written in the memory at every 16 lines.

[0067] Since this time is determined by controlling the CPAL signal from the CPU circuit unit 1025, the CPAL signal is set at H level at every time intervals corresponding to 16 lines, and after formation of histogram data for one line,

the CPAL signal is set at L level.

[0068] Fig. 7A shows a histogram forming range of this embodiment, and Fig. 7B shows a sampling interval of this embodiment.

[0069] The relationship between sampling operations and a histogram forming range for an original will be explained below with reference to Figs. 7A and 7B.

[0070] In Fig. 7A, when the sampling interval is 1 mm, and the memory for storing histogram data is a 16-bit memory, since the maximum frequency corresponding to about 65,000 data can be stored, an A4-size (210 mm x 297 mm) histogram forming range is obtained.

[0071] In Fig. 7B, data are sampled at every 16 dots in the main scan direction, and at every 16 lines in the sub-scan direction. Since the pre-scan speed is equal to a normal reading speed (equal magnification), sampled data corresponds to one pixel to be normally read.

[Detection of Feature Points of Histogram (S2)]

[0072] Upon repetition of the above-mentioned processing, a histogram is formed, as shown in Fig. 9.

[0073] Fig. 9 shows a histogram of a typical original. This histogram is the most popular one for a normal original. That is, an original includes a background portion (to be also referred to as a non-information portion hereinafter) having almost the same density over a wide range, and characters and the like are written thereon at a density higher than that of the background portion. The signal level is plotted along the abscissa. Since the number of reading levels is 256, the left end corresponds to 0th level (darkest), and the right end corresponds to 255th level (lightest). The frequency is plotted along the ordinate, and is normally considered as the total frequency ratio (%).

[0074] The following four feature points of the histogram are obtained.

ℓmin	darkest signal level
ℓmax	lightest signal level
ℓpeak	signal level corresponding to maximum frequency
hmax	maximum frequency

In this histogram, a signal level (luminance signal level) range to have ℓpeak as the center corresponds to a background portion (non-information portion), and a range from ℓmin to the non-information portion corresponds to a character portion (an information portion of an original).

[0075] Fig. 10 is a flow chart for obtaining feature points of a histogram according to the first embodiment. In Fig. 10, ℓ represents the level, and h(ℓ) represents the frequency. In detection of the darkest level ℓmin in steps S11 to S16, the frequencies h(ℓ) according to levels ℓ are sequentially checked from the 0th level toward the 255th level, and the level ℓ of the frequency h(ℓ) exceeding a discrimination reference frequency LJUG first is adopted. The discrimination reference frequency LJUG is used for eliminating a discrimination error caused by, e.g., noise upon formation of a histogram, and is set to be about 0.01% of the total frequency value. For example, if the total frequency value is 65,000, LJUG is 65, and a level having a frequency equal to or larger than 65 is detected.

[0076] In detection of the lightest level ℓmax, similarly, in steps S17 to S22, the frequencies are checked from the 255th level toward the 0th level, and the level of the frequency, which exceeds LJUG first, is adopted. When these levels cannot be detected for some reason, 0 is given to ℓmin, and 255 is given to ℓmax.

[0077] In steps S23 to S27, the maximum frequency hmax of the histogram, and the level ℓpeak of the maximum frequency are then detected from the range from ℓmin to ℓmax.

[Discrimination of Original Type (Formation of Conversion Table) (S3)]

[0078] Fig. 11 is a flow chart for explaining an operation for discriminating an original type.

[0079] An original type is discriminated based on the feature point data of the histogram obtained in step S2. In this embodiment, the original type is classified to three types, i.e., a normal image type, a reversal image type, and a gradation image type, and a table for converting luminance signals according to a corresponding method is formed. This conversion table is formed to faithfully reproduce an original image of the corresponding type or to emphasize, e.g., the density.

[0080] Fig. 12 shows a histogram of an original of the normal image type. An original of the type shown in Fig. 12 is the same as that shown in Fig. 9, and most of originals are included in this type. An original of this type is preferably subjected to processing for increasing the density of light characters written by, e.g., a pencil included in a character portion (information portion) without recording a background portion (non-information portion).

[0081] Fig. 13 shows a histogram of an original of the reversal image type. An original of the type shown in Fig. 13 has a frequency peak in a direction opposite to that of an original of the normal image type, and corresponds to an

original on which white characters are present on a solid-color background portion. An original of this type is preferably subjected to processing for recording a portion corresponding to the background portion (non-information portion) to be darker, and preventing slight background fogging of a white character portion.

[0082] Fig. 14 shows a histogram of an original of the gradation image type. An original of the type shown in Fig. 14 corresponds to an original such as a photograph having a smooth, continuous change in original density, and a conversion table preferably has linear input/output characteristics so as not to impair gradation characteristics.

[0083] The meanings of symbols in Fig. 11 will be listed below.

HLIM reference frequency for discriminating gradation image type
IWLIM discrimination reference level of information width for discriminating gradation image type
ILIM discrimination reference level of normal image type and reversal image type

In Fig. 11, in step S31, the maximum frequency hmax of the histogram is compared with the frequency HLIM. If the maximum frequency is smaller than the frequency HLIM, it is determined that an original type may be the gradation image type, and the information width is checked. The value of the frequency HLIM is determined to be about 1.5% of the total frequency value based on many image data. If the total frequency value is 65,000, the value of the frequency HLIM is 975.

[0084] In step S32, the information width is obtained from the values of the darkest level ℓmin and the lightest level ℓmax, and is compared with the level IWLIM. As a result, if the information width is larger than the level IWLIM, the original type is finally determined as the gradation image type. The value of the level IWLIM is determined in the same manner as the frequency HLIM, and is set to be 200 in this embodiment.

[0085] If a comparison result other than the above-mentioned comparison result with the frequency HLIM or the level IWLIM is obtained, the signal level ℓpeak of the maximum frequency is compared with the level ILIM to determine the normal or reversal image type in step S33. If the signal level ℓpeak is larger than the level ILIM, the normal image type is determined; otherwise, the reversal image type is determined. With this level ILIM, a background (non-information) density to be output or not to be output is determined. In this embodiment, the value of the level ILIM is set to be 160.

[0086] A conversion table is formed as follows according to the image type discriminated as described above. Figs. 12 to 14 show the characteristics of conversion tables.

[0087] Fig. 12 shows the conversion table of the normal image type.

[0088] A level corresponding to a background portion (non-information non-information portion) is obtained. When the density is uniform, since it is considered that the density has a distribution axially symmetrical about the maximum frequency level ℓpeak, the non-information level is determined by subtracting ℓmax - ℓpeak from ℓpeak.

[0089] The conversion table is obtained by the following relations:

$$\text{Iin} \geq \ell\text{peak} - (\ell\text{max} - \ell\text{peak}) \rightarrow \text{Iout} = 255$$

$$\text{Iin} \leq \ell\text{min} \rightarrow \text{Iout} = 0$$

$$\text{others} \rightarrow \text{Iout} = 255 \times (\text{Iin} - \ell\text{min})/(\ell\text{peak} - (\ell\text{max} - \ell\text{peak}) - \ell\text{min})$$

[0090] where Iin is the input level, and Iout is the output level.

[0091] Fig. 13 shows the conversion table of the reversal image type.

[0092] Since the non-information portion must be emphasized to be darker, a level portion lower than the level ℓpeak is converted to 0 level. In order to eliminate fogging of a white character portion of the reversal image, IOFF is used as an offset level from the lightest level. In this case, "10" is set.

[0093] The conversion table is obtained by the following relations:

$$\text{Iin} \geq \ell\text{max} - \text{IOFF} \rightarrow \text{Iout} = 255$$

$$\text{Iin} \leq \ell\text{peak} \rightarrow \text{Iout} = 0$$

$$\text{others} \rightarrow \text{Iout} = 255 \times (\text{Iin} - \ell\text{peak})/(\ell\text{max} - \text{IOFF} - \ell\text{peak})$$

where Iin is the input level, and Iout is the output level.

[0094] Fig. 14 shows the conversion table of the gradation image type.

[0095] In order to maintain gradation characteristics, a linear conversion table is formed. That is, the table is expressed by:

$$\text{Iout} = \text{Iin}$$

[Formation of γ Table (S4)]

[0096] The final γ table is formed based on the conversion table obtained in the processing in steps S1 to S3.

[0097] The density correction unit 36 (Fig. 3) performs density conversion and gradation conversion for correcting the gradation characteristics of a printer using an LUT (look-up table). In the density conversion processing, the read luminance signals are converted into density signals, and this processing is generally called "log conversion". The log conversion table is calculated from the following equation:

$$\text{Dout} = -255/\text{DMAX}*\text{LOG}(\text{Din}/255)$$

[0098] A gradation correction table will be described below.

[0099] The gradation correction table corrects the gradation characteristics of a printer. Fig. 15A shows an example of gradation characteristics of an electrophotography printer. Fig. 15B shows the characteristics of a correction table for the gradation characteristics shown in Fig. 15A.

[0100] The gradation correction table is expressed by:

$$\text{Correction data} = \text{gradation correction } (-255/\text{DMAX}*\text{LOG}(\text{Din}/255))$$

The conversion tables for density conversion and gradation correction obtained as described above are stored in the ROM of the CPU as tables, and optimal data are selected. Furthermore, the luminance signal conversion table obtained by the AE processing is combined with these tables to form a final table. These processing operations are executed according to a program of the CPU.

[0101] The density correction unit 36 comprises a programmable storage element such as a RAM, and is written with the obtained γ table data from the CPU. The γ table data are calculated every time an original is exchanged, and are written in the density correction unit 36.

Second Mode

[0102] In the main scan operation, an original image is reproduced using the conversion table corresponding to the original type and the γ table respectively obtained in steps S2 and S4 by the pre-scan operation. In this manner, when an original is copied, reproduction signals of the original are generated according to the two tables formed by the pre-scan operation.

[0103] As described above, according to this embodiment, a histogram of an original is formed, and a luminance signal conversion table is formed based on feature point data of the histogram. Then, LUTs including a log conversion table and a gradation correction table for a printer are formed. In this manner, an original density and type can be automatically determined, and an original image can be faithfully reproduced without selecting a density button or an original type selection button unlike in the prior art.

[0104] An original image can be recorded while emphasizing a light information portion (character portion) to be darker without recording an unnecessary portion (a background portion, i.e., a non-information portion). An original having gradation characteristics (an original such as a photograph having a slow change in density level) can be recorded without impairing gradation characteristics.

[0105] When an original obtained after repetitive copying operations is to be copied, since optimal conversion tables are formed for the original, a copy, which suffers from less blurring of characters or deterioration of image quality, can

be obtained.

<Second Embodiment>

[0106] Another AE processing according to the second embodiment of the present invention will be described below. Since this embodiment has the same arrangement as that corresponding to Figs. 1 to 7B described in the first embodiment, a detailed description thereof will be omitted. Since individual operations in the flow chart shown in Fig. 8 are different from those in the first embodiment, the differences will be explained mainly below. The AE processing of this embodiment is executed in the order of formation of a histogram (S1'), detection of feature points of the histogram (S2'), discrimination of an original type (S3'), and formation of a γ table (S4'). Thus, step S2' and subsequent steps different from those in the first embodiment will be described below.

[Detection of Feature Points of Histogram (S2')]

[0107] In the second embodiment, in order to analyze a histogram pattern in detail, all peaks of the histogram are obtained. The method of obtaining the peaks will be briefly described below. Signal levels are sequentially checked from the 0th level to 255th level, and when the frequency of the level of interest is equal to or larger than a peak discrimination reference value YLIM, and is larger than frequencies of the levels immediately before and after the level of interest, the level of interest is recognized as a peak by setting "1" in the corresponding level number of an array pdata. In this embodiment, the value YLIM is set to be 0.03% of the total frequency value. The array pdata has 256 areas, and is initialized to "0" in advance.

[0108] The following data are obtained as feature points of the histogram.

peakn	total number of peaks
ℓpeakn	total number of peaks of dark portion
rpeakn	total number of peaks of light portion
Imax	signal level corresponding to maximum frequency
Ilight	lightest signal level
Idark	darkest signal level
rpeak	darkest peak of peaks recognized as peaks of background portion in light portion
rwidth	continuous amount of frequencies having largest width of regions where frequencies exceeding given level continuously appear

[0109] In this histogram, a range of signal levels (luminance signal levels) to have Imax as a center corresponds to a background portion (non-information portion), and a range from Idark to the non-information portion corresponds to a character portion (an information portion of an original).

[0110] The method of obtaining these data will be described below.

[0111] In order to detect peakn, the array pdata is sequentially checked from 0 to 255, and the number of levels recognized as peaks is obtained.

[0112] In order to detect ℓpeakn, the array pdata is sequentially checked from 0 to a threshold value ILIM between the dark and light portions, and the number of levels recognized as peaks is obtained.

[0113] In order to detect rpeakn, the array data is sequentially checked from 255 to the threshold value ILIM between the dark and light portions, and the number of levels recognized as peaks is obtained.

[0114] In order to detect rpeak, the array data is sequentially checked from 255 to the threshold value ILIM between the dark and light portions, and a level value of an n-th detected peak (when rpeakn > n) or an (rpeakn)-th detected peak (when rpeakn ≦ n) is adopted.

[0115] In order to detect the darkest level Idark, the frequencies are sequentially checked from the 0th level toward the 255th level, and the level of the frequency, which exceeds a discrimination reference frequency doslim first, is adopted. This discrimination reference frequency doslim is used for eliminating a discrimination error caused by, e.g., noise upon formation of a histogram, and is set to be about 0.01% of the total frequency value. For example, if the total frequency value is 65,000, the frequency doslim is 65, and a level having a frequency equal to or larger than 65 is detected.

[0116] In order to detect the lightest level Ilight, similarly, the frequencies are sequentially checked from the 255th level toward the 0th level, and the level of the frequency, which exceeds doslim first, is adopted. If these levels cannot be detected for some reason, "0" is given to Idark, and "255" is given to Ilight.

[0117] The maximum frequency hmax and the level Imax at that time are obtained by detecting the maximum frequency within a range from the Idark to Ilight.

[0118] In order to detect rwidth, the frequencies are sequentially checked from the 0th level toward the 255th level,

a period having the maximum width of levels is obtained from periods where frequencies equal to or larger than doslim continuously appear, and the continuous amount of the frequencies in the period is adopted.

[Discrimination of Original Type (Formation of Conversion Table) (S3')]

[0119] Fig. 16 is a flow chart for explaining an operation for discriminating an original type according to this embodiment. An original type is discriminated based on feature point data of the histogram, which are obtained in step S2'. In this embodiment, an original type is classified to three types, i.e., a normal image type, a reversal image type, and a gradation image type, and a table for converting luminance signals by the corresponding method is formed.
[0120] The conversion table is formed to faithfully reproduce an original image of the corresponding type or to emphasize, e.g., the density, and is used for converting luminance signals.
[0121] Fig. 17 shows a histogram of an original of the normal image type in this embodiment. As shown in Fig. 17, an original of the normal image type is preferably subjected to processing for increasing the density of light characters written by, e.g., a pencil included in a character portion (information portion) without recording a background portion (non-information portion). Most of originals are included in this type.
[0122] Fig. 18 shows a histogram of an original of the reversal image type in this embodiment. As shown in Fig. 18, an original of the reversal image type has a frequency peak in a direction opposite to that of an original of the normal image type, and corresponds to an original on which white characters are present on a solid-color background portion. An original of this type is preferably subjected to processing for recording a portion corresponding to the background portion (non-information portion) to be darker, and preventing slight background fogging of a white character portion.
[0123] Fig. 19 shows a histogram of an original of the gradation image type in this embodiment. As shown in Fig. 19, an original of the gradation image type corresponds to an original such as a photograph having a smooth, continuous change in original density, and a conversion table preferably has linear input/output characteristics so as not to impair gradation characteristics.
[0124] The meanings of symbols in Fig. 16 will be listed below.

HLIM	reference frequency for discriminating gradation image type
ILIM	discrimination reference level of normal image type and reversal image type
IWLIM	discrimination reference level of information width for discriminating gradation image type
PWIDTH	discrimination reference level of continuity for discriminating gradation image type
WAREA	discrimination reference level of normal image type and gradation image type

[0125] In Fig. 16, it is checked in step S101 if the total number peakn of peaks is 0. If YES in step S101, the gradation image type is determined in step S110. However, if it is determined in step S101 that the total number of peaks is equal to or larger than 1, the maximum frequency hmax of the histogram is compared with HLIM in step S102. If the maximum frequency is smaller than HLIM, the information width is checked in step S103. The value of HLIM is determined to be about 1.5% of the total frequency value based on many image data. If the total frequency value is 65,000, the value of HLIM is 975.
[0126] The information width is then calculated from the values of the darkest level Idark and the lightest level Ilight, and is compared with IWLIM. If the information width is equal to or larger than IWLIM, the gradation image type is determined in step S110. The value of IWLIM is determined in the same manner as HLIM, and is set to be 200 in this embodiment.
[0127] If hmax is equal to or larger than HLIM, and if the information width is smaller than IWLIM, rwidth and PWIDTH are compared with each other in step S104. If rwidth is equal to or larger than PWIDTH, step S105 is executed; otherwise, step S107 is executed. The value of PWIDTH is set to be 60 on the basis of many image data in this embodiment. It is checked in step S105 if the number rpeakn of peaks of the light portion is 0. If YES in step S105, the gradation image type is determined. However, if it is determined in step S105 that rpeakn is equal to or larger than 1, rpeak is compared with WAREA in step S106. If rpeak is larger than WAREA, the gradation image type is determined. However, if rpeak is equal to or smaller than WAREA, the normal image type is determined.
[0128] The value of WAREA is set to be 192 in this embodiment. In general, since frequencies equal to or larger than a given level continuously appear in a histogram of a gradation image, the gradation image can be determined by checking if the histogram includes such a continuous region. However, with this method, a newspaper original, which should be determined as a normal original, may be erroneously determined as a gradation image. In the case of a newspaper original, since the peak of a background color portion of a newspaper appears in a light portion, the newspaper original can be prevented from being determined as a gradation original by checking the conditions in steps S105 and S106.
[0129] If it is determined in step S104 that rwidth is smaller than PWIDTH, the signal level Imax of the maximum frequency is compared with ILIM. If Imax is equal to or larger than ILIM, the normal image type is determined; otherwise,

the reversal image type is determined.

[0130] With the ILIM, a background (non-information) density to be output or not to be output is determined. In this embodiment, the value of ILIM is set to be 130.

[0131] A conversion table is formed according to the discriminated image type. If the input level is represented by Iin, and the output level is represented by Iout, the conversion table is expressed by the following relations (2):

$$\text{When } Iin < black,\ Iout = 0$$

$$\text{When } black \leq Iin \leq white,$$

$$Iout = (255/(white - black))*(x - black)$$

$$\text{When } Iin > white,\ Iout = 255 \qquad (2)$$

A method of obtaining black and white in relations (2) will be explained below in correspondence with the image types.

<Normal Image Type>

[0132] Fig. 20 is a flow chart showing a subroutine for obtaining white of the normal image type in this embodiment. In step S201, rpeak is compared with a fogging prevention reference value KLIM. If rpeak is larger than KLIM, a turn value KTURN is set in step S205; otherwise, processing in step S202 is executed. The value of KTURN is set to be 4 in this embodiment.

[0133] In step S202, the difference between rvalley and rpeak is compared with LIGHT. LIGHT is a limit value of a turn amount for preventing overwhitening of a non-information portion, and is set to be 16 in this embodiment. When rpeakn is 1, rvalley corresponds to Ilight; when rpeak is not the lightest one of peaks appearing in a light portion, the levels are sequentially checked from rpeak toward the next lightest peak, and a level, which becomes smaller than doslim first, or a level having the minimum frequency in the period is determined as rvalley. If the condition in step S202 is satisfied, a turn value turn is set to be LIGHT in step S204; otherwise, a difference obtained by subtracting rpeak from rvalley is set as the turn value turn in step S203.

[0134] After these processing operations, a value obtained by subtracting turn from rpeak is set in white in step S206.

[0135] A method of obtaining black will be described below.

[0136] Fig. 21 is a flow chart showing a subroutine for obtaining black of the normal image type in this embodiment.

[0137] Since Idark is the darkest level, black is preferably equal to Idark. However, when some levels each having a frequency smaller than the threshold value doslim for determining noise are present between 0 and Idark, it is preferable to prevent emphasis of noise by correcting Idark. Thus, black = Idark is set (S301), and the number of levels having frequencies equal to or larger than 0 is checked between 0 to Idark. For example, if the number of levels is equal to or larger than 32 (S302), the darkest one of levels having frequencies larger than 0 is set as Idark (S303).

[0138] In step S304, a value obtained by subtracting black from white is compared with a smallest value CONTLIM of a level width to be provided with a contrast. If the difference is smaller than CONTLIM, black is set to be 0 in step S305. This is to prevent overemphasis of the contrast due to too small an interval between white and black when an original consists of only a non-information portion, or when the density of an original is very low. Note that CONTLIM is set to be 55 in this embodiment.

<Reversal Image Type>

[0139] A method of forming a conversion table of the reversal image type will be described below.

[0140] Fig. 22 is a flow chart showing a subroutine for obtaining black of the reversal image type in this embodiment. If it is determined in step S401 that peakn is larger than 1, Idark is set as black in step S403; otherwise, Imax is set as black in step S402.

[0141] Fig. 23 is a flow chart showing a subroutine for obtaining white of the reversal image type in this embodiment. In step S501, Ilight is compared with ILIM. If Ilight is smaller than ILIM, white is set to be 255 in step S507. If Ilight is equal to or larger than ILIM, the number rpeakn is checked in step S502. If rpeakn = 0, a value obtained by subtracting IOFF from Ilight is set as white in step S506; otherwise, a value obtained by subtracting rpeak from rvalley is compared with LIGHT in step S503. If rvalley - rpeak is larger than LIGHT, a value obtained by subtracting LIGHT from rpeak is set as white in step S505; otherwise, rpeak - (rvalley - rpeak) is set as white. IOFF is a value used for preventing fogging of a white character portion of a reversal image, and is set to be 10 in this embodiment.

[0142] If it is then determined in step S508 that the difference between white and black is smaller than the contrast

width CONTLIM, white is set to be 255 in step S509.

<Gradation Image Type>

[0143] As can be seen from the conversion table of the gradation image type shown in Fig. 19, since gradation characteristics must be maintained, a linear conversion table is formed. For this purpose, black is set to be 0, and white is set to be 255.

[0144] As described above, according to the second embodiment as well, the same effect as in the first embodiment can be obtained. After a first mode attained by a pre-scan operation, processing in a second mode attained by a main scan operation is executed. The operation in this mode is the same as that in the first embodiment, and a detailed description thereof will be omitted.

<Third Embodiment>

[0145] In the embodiments described above, data are temporarily written in a memory, and are read out by the CPU circuit unit to form a histogram. Such processing can also be realized by a hardware circuit arrangement shown in Fig. 24. Portions other than those to be described below are the same as those in the above embodiments, and a detailed description thereof will be omitted.

[0146] Fig. 24 is a block diagram showing an arrangement of a histogram forming unit according to the third embodiment of the present invention.

[0147] Referring to Fig. 24, reference numeral 100 denotes a programmable memory such as a RAM, which has a capacity of 256 words. Reference numeral 101 denotes an adder circuit for incrementing the readout content of the memory by 1, and rewriting the incremented content in the memory. Reference numeral 102 denotes a control circuit for generating a write signal for writing luminance signals obtained in a pre-scan operation in the memory 100 at designated sampling intervals. The sampling interval and range are set by a CPU.

[0148] Reference numerals 103 and 104 denote data selectors for selecting hardware control or CPU circuit unit control according to a sel signal from the CPU circuit unit. Reference numeral 105 denotes a buffer for controlling the direction of data when data is read out by the CPU circuit unit.

[0149] In the description of each of the embodiments described above, the pre-scan speed is set to be an equal-magnification speed in a read mode, the histogram forming range is set to be an A4-size range, and the sampling intervals in the main scan and sub-scan directions are set to be 1 mm. However, the present invention is not limited to these.

[0150] The pre-scan speed may be increased to shorten the pre-scan time. In this case, sampling can be performed for a range elongated in the sub-scan direction, and a histogram can be formed for a range wider than that can be obtained by the pre-scan operation at the equal-magnification speed.

[0151] The sampling interval is not limited to 1 mm, but may be, e.g., about 2 to 3 mm. The sampling range is not limited to an A4-size range. That is, when a histogram is formed for a range according to an original size, it can express the characteristics of the original itself better.

[0152] In each of the above embodiments, histogram data obtained in detection of feature points of a histogram are directly used. However, the frequencies of adjacent signal levels may be averaged to execute conversion processing. For example, a range of three to five pixels may be used. In this case, a discrimination error can be eliminated.

[0153] In each of the above embodiments, the darkest and lightest levels are obtained using a level having a frequency 0.15% of the total frequency value as a detection reference level. In place of the reference level, a detection level may be determined when frequency levels of a certain signal level continuously appear.

[0154] The detection reference level may be determined by defining the maximum frequency as 100%.

[0155] In each of the above embodiments, different conversion tables are prepared in correspondence with original types. Alternatively, as shown in Figs. 25A and 25B, an optimal conversion table may be calculated by setting corresponding offset values.

[0156] Figs. 25A and 25B show input/output characteristics obtained when a conversion table is formed in consideration of an offset.

[0157] In Figs. 25A and 25B, offsets IOFF1 to IOFF6 are set in correspondence with original types so as to obtain an optimal copy desired by a user. These offsets may be independently set from a scanning unit, or a corresponding copy result may be designated (e.g., setting for obtaining a darker or lighter copy).

[0158] In each of the above embodiments, HLIM (a reference frequency for discriminating the gradation image type) and IWLIM (an information width for discriminating the gradation image type) are used as references for discriminating the original type. However, the present invention is not limited to these. For example, the differences between the frequencies of all signal levels of a histogram or the ratio of a total frequency of a specific signal level may be used for discrimination.

[0159] Other feature points of a histogram may be used. For example, a maximum frequency level in a character portion, a level at a position where a difference in frequency checked from the maximum frequency level is smaller than a reference value, a level at a position where an accumulated frequency from the darkest or lightest level exceeds a reference value may be used.

[0160] Of peaks in a dark portion, peak as the darkest level is detected, and when the reversal image type is determined, the value of black may be set to be peak.

[0161] In the above embodiment, a histogram is formed using luminance signals (0 = dark, 255 = light), but may be formed using density signals (obtained by inverting luminance signals).

[0162] In this case, the right- and left-hand sides of the histograms shown in Figs. 12, 13, and 14 are reversed.

[0163] The histogram forming unit 38 is arranged before variable magnification processing, but may be arranged after variable magnification processing or after an MTF correction circuit in the image processing unit.

[0164] A conversion table is arranged at the final position in the image processing unit, but may be arranged before or after the variable magnification unit 34. That is, the position of the conversion table is not particularly limited. The conversion table is calculated every time an original is exchanged. However, some conversion tables may be calculated, and an optimal one may be selected according to feature points of a histogram.

[0165] In each of the above embodiments, a histogram is formed in one color regardless of the original color, but may be formed in correspondence with each original color.

[0166] In this case, for example, two histograms are formed in correspondence with original colors (e.g., red and an achromatic color (black, white)), and different conversion tables may be calculated in correspondence with these original colors. This processing allows optimal density conversion for an original, and can eliminate the adverse affect of color sensitive characteristics of a reading system.

[0167] A histogram may be formed based on a signal obtained by mixing R, G, and B signals at an arbitrary ratio.

[0168] Furthermore, when the level rpeak for recognizing a non-information portion of a light portion is determined, a user may select a peak to be recognized as a non-information portion.

[0169] Also, the values of MLIM, ILIM, IWLIM, PWIDTH, WAREA, and LIGHT may be set by a user.

[0170] When a conversion table of the normal image type is formed, if the difference between black and white is smaller than the contrast width, black = 0 is set. Alternatively, the noise level may be lowered between 0 and white - CONTLIM so as to correct black. In this case, a level having a largest frequency of levels having frequencies exceeding a new noise level may be set as black, or a darkest level may be set as black. If an optimal level cannot be found, the noise level may be further lowered, or a proper offset value, e.g., ILIM - LIGHT - CONTLIM may be set as black. In this manner, an original having a very low density can be reproduced without overemphasizing contrast.

[0171] Since a photograph original often include a very dark reading level, if data having a certain frequency or more are found between levels 0 and 4, a gradation image original may be determined.

[0172] Note that the present invention may be applied to a system constituted by a plurality of devices, or may be applied to an apparatus consisting of a single device. Also, the present invention may also be applied to a case wherein the invention is achieved by supplying a program to a system or an apparatus.

[0173] As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

Claims

1. An image processing apparatus comprising:

input means (1022) for inputting image data representing an original;
first forming means (38) for forming a histogram based on the image data;
detecting means (1025) for detecting feature points (lmax, lmin, lpeak, ldark, rpeak) of the histogram;
second forming means (1025) for providing a conversion table for performing a conversion on the image data;
processing means (1023) for processing the image data by using the conversion table;

characterized in that

said second forming means is adapted to discriminate, in accordance with feature points detected by said detecting means, whether an image type of an original represented by inputted image data is at least of a first type or of a second type which are different from each other; and to form said conversion table for performing a conversion on the image data by using a first set of feature points if the image is of the first type, or a second set of feature points if the image is of the second type, said first set of feature points being at least partly

different from said second set of feature points.

2. Apparatus according to claim 1, wherein said second forming means are adapted in response to the discrimination of the image type to form a first conversion table when the image type has been discriminated as being a normal image and to form a second conversion table when the image type has been discriminated as a reversal image.

3. Apparatus according to claim 2, wherein said second forming means are adapted to discriminate in accordance with feature points detected by said detecting means whether the image type is a normal type, a reversal type or a gradation type, and to form a third conversion table in which the relationship between the input image data and the output data is substantially linear when the image type is discriminated to be of the gradation type.

4. Apparatus according to any preceding claim, wherein said first forming means form the histogram by sampling a luminance component of said image data and storing the sampled data in a memory (50).

5. Apparatus according to any preceding claim, wherein said conversion table converts luminance data into density data.

6. Apparatus according to any preceding claim, wherein said feature points include lightest and darkest levels of the image data as represented on the histogram.

7. Apparatus according to claim 6, wherein the second forming means is adapted to carry out discrimination on all the peaks of the histogram.

8. Apparatus according to claim 7, wherein the peaks in the histogram are determined by sequentially checking signal levels and denoting as peaks each signal level which is equal to or larger than a peak discrimination reference value.

9. Apparatus according to claim 8, wherein the peak values used to discriminate whether or not the original image is a normal image comprise a first feature point (Idark) representing the darkest signal level, and a second feature point (rpeak) representing the darkest peak of peaks recognised as being peaks of the background portion of the normal image.

10. Apparatus according to claim 8 or claim 9, wherein the peak values used to discriminate whether or not the original image is a reversal image comprise a feature point (Imax) the signal level which corresponds to the maximum frequency in the histogram and said second feature point.

11. Apparatus according to any preceding claim, wherein said input means is an image reader for scanning an original and generating the image data.

12. Apparatus according to claim 11, wherein said second forming means is adapted to form the conversion table when said image reader performs a pre-scanning operation on said original.

13. Apparatus according to any preceding claim, further comprising image forming means for forming a reproduction image on a medium based on the image data output from said processing means.

14. An image processing method comprising:

inputting image data representing an original;
forming a histogram based on the image data;
detecting feature points (Imax, Imin, Ipeak, Idark, rpeak) of the histogram;
providing a conversion table for performing a conversion on the image data; and
processing the image data using the conversion table;

characterized by

in accordance with feature points detected by said detecting means, it is discriminated whether an image type of an original represented by the inputted image data is at least of a first type or of a second type which are different from each other; and by forming the conversion table for performing conversion on the image data by using a first set of feature points if the image is of the first type, or a second set of feature points if the image

is of the second type, said first set of feature points being at least partly different from said second set of feature points.

15. A method according to claim 14, and in response to the discrimination of the image type forming a first conversion table when the image type has been discriminated as being a normal image and a second conversion table when the image type has been discriminated as a reversal image.

16. A method according to claim 15, including discriminating in accordance with detected feature points whether the image type is a normal type, a reversal type or a gradation type, and forming a third conversion table in which the relationship between the input image data and the output data is substantially linear when the image type is discriminated to be of the gradation type.

17. A method according to any one of claims 14 to 16, wherein the histogram is formed by sampling a luminance component of said image data and storing the sampled data in a memory (50).

18. A method according to any one of claims 14 to 17, wherein said conversion table converts luminance data into density data.

19. A method according to any one of claims 14 to 18, wherein said feature points include lightest and darkest levels of the image data as represented on the histogram.

20. A method according to claim 19, wherein the discrimination is carried out on all the peaks of the histogram and the peaks in the histogram are determined by sequentially checking signal levels and denoting as peaks each signal level which is equal to or larger than a peak discrimination reference value.

21. A method according to claim 20, wherein the peak values used to discriminate whether or not the original image is a normal image comprise a first feature point (Idark) representing the darkest signal level, and a second feature point (rpeak) representing the darkest peak of peaks recognised as being peaks of the background portion of the normal image.

22. A method according to claim 20 or claim 21, wherein the peak values used to discriminate whether or not the original image is a reversal image comprise a feature point (Imax) the signal level which corresponds to the maximum frequency in the histogram and said second feature point.

23. Apparatus according to any one of claims 14 to 22, wherein said image data is input from an image reader which scans an original to generate the image data.

24. A method according to claim 22 or claim 23, wherein the conversion table is formed by said image reader performing a pre-scanning operation on said original.

25. A method according to any one of claims 14 to 24, further comprising forming a reproduction image on a medium based on the converted image data.

Patentansprüche

1. Bildverarbeitungsgerät mit:

einer Eingabevorrichtung **(1022)** zum Eingeben von eine Vorlage repräsentierenden Bilddaten;
einer ersten Erzeugungseinrichtung **(38)** zum Erzeugen eines auf den Bilddaten basierenden Histogramms;
einer Erfassungseinrichtung **(1025)** zum Erfassen charakteristischer Punkte **(Imax, Imin, Ipeak, Idark, rpeak)** des Histogramms;
einer zweiten Erzeugungseinrichtung **(1025)** zum Bereitstellen einer Umwandlungstabelle zum Durchführen einer Umwandlung der Bilddaten;
einer Verarbeitungseinrichtung **(1023)** zum Verarbeiten der Bilddaten unter Verwendung der Umwandlungstabelle;

dadurch gekennzeichnet, daß

die zweite Erzeugungseinrichtung ausgestaltet ist zum Unterscheiden, ob es sich bei einem Bildtyp einer durch eingegebene Bilddaten repräsentierten Vorlage zumindest um einen ersten Typ oder einen zweiten Typ handelt, die voneinander verschieden sind, entsprechend den durch die Erfassungseinrichtung erfaßten charakteristischen Punkten; und zum Bilden der zum Durchführen einer Umwandlung der Bilddaten verwendeten Umwandlungstabelle durch Verwenden einer ersten Gruppe charakteristischer Punkte, falls das Bild vom ersten Typ ist, oder einer zweiten Gruppe charakteristischer Punkte, falls das Bild vom zweiten Typ ist, wobei sich die erste Gruppe charakteristischer Punkte zumindest teilweise von der zweiten Gruppe charakteristischer Punkte unterscheidet.

2. Gerät nach Anspruch 1, wobei die zweite Erzeugungseinrichtung ausgestaltet ist zum auf die Unterscheidung ansprechenden Bilden einer ersten Umwandlungstabelle, wenn als Bildtyp ein normales Bild unterschieden wurde, und einer zweiten Umwandlungstabelle, wenn als Bildtyp ein Umkehrbild unterschieden wurde.

3. Gerät nach Anspruch 2, wobei die zweite Erzeugungseinrichtung ausgestaltet ist zum von den durch die Erfassungseinrichtung erfaßten charakteristischen Punkten abhängigen Unterscheiden, ob es sich bei dem Bildtyp um einen normalen Typ, einen Umkehrtyp oder einen Gradationstyp handelt, und zum Bilden einer dritten Umwandlungstabelle, in der das Verhältnis zwischen den Eingangsbilddaten und den Ausgangsdaten im wesentlichen linear ist, wenn als Bildtyp der Gradationstyp unterschieden wurde.

4. Gerät nach einem der vorgenannten Ansprüche, wobei die erste Erzeugungseinrichtung das Histogramm durch Abtasten einer Helligkeitskomponente der Bilddaten und Speichern der Abtastdaten in einem Speicher **(50)** bildet.

5. Gerät nach einem der vorgenannten Ansprüche, wobei die Umwandlungstabelle Helligkeitsdaten in Dichtedaten umwandelt.

6. Gerät nach einem der vorgenannten Ansprüche, wobei die charakteristischen Punkte hellste und dunkelste Pegel der auf dem Histogramm dargestellten Bilddaten enthalten.

7. Gerät nach Anspruch 6, wobei die zweite Erzeugungseinrichtung ausgestaltet ist zum Durchführen der Unterscheidung bezüglich aller Spitzenwerte des Histogramms.

8. Gerät nach Anspruch 7, wobei die Spitzenwerte des Histogramms bestimmt werden durch sequentielles Überprüfen der Signalpegel und Kennzeichnen aller Signalpegel als Spitzenwerte, die größer oder gleich einem Spitzenwertunterscheidungsbezugswert sind.

9. Gerät nach Anspruch 8, wobei diejenigen Spitzenwerte, die zur Unterscheidung dahingehend, ob das Vorlagenbild ein normales Bild ist oder nicht, herangezogen werden, einen den dunkelsten Signalpegel repräsentierenden ersten charakteristischen Punkt **(Idark)** und einen den dunkelsten Spitzenwert der als Hintergrundbereich des normalen Bilds erkannten Spitzenwerte repräsentierenden zweiten charakteristischen Punkt **(rpeak)** umfassen.

10. Gerät nach Anspruch 8 oder Anspruch 9, wobei diejenigen Spitzenwerte, die zur Unterscheidung dahingehend, ob das Vorlagenbild ein Umkehrbild ist oder nicht, herangezogen werden, einen charakteristischen Punkt **(Imax)**, dessen Signalpegel der maximalen Frequenz in dem Histogramm entspricht, und den zweiten charakteristischen Punkt umfassen.

11. Gerät nach einem der vorgenannten Ansprüche, wobei die Eingabevorrichtung ein Bildleser zum Abtasten einer Vorlage und Erzeugen der Bilddaten ist.

12. Gerät nach Anspruch 11, wobei die zweite Erzeugungseinrichtung ausgestaltet ist zum Bilden der Umwandlungstabelle, wenn der Bildleser eine Vorabtastoperation der Vorlage durchführt.

13. Gerät nach einem der vorgenannten Ansprüche, weiterhin umfassend eine Bilderzeugungseinrichtung zum Erzeugen eines Wiedergabebilds auf einem Medium basierend auf den von der Verarbeitungseinrichtung ausgegebenen Bilddaten.

14. Bildverarbeitungsverfahren mit:

Eingeben von eine Vorlage repräsentierenden Bilddaten;

Erzeugen eines auf den Bilddaten basierenden Histogramms;
Erfassen charakteristischer Punkte (Imax, Imin, Ipeak, Idark, rpeak) des Histogramms;
Bereitstellen einer Umwandlungstabelle zum Durchführen einer Umwandlung der Bilddaten; und
Verarbeiten der Bilddaten unter Verwendung der Umwandlungstabelle;

gekennzeichnet durch

Unterscheiden, ob es sich bei einem Bildtyp einer durch eingegebene Bilddaten repräsentierten Vorlage zumindest um einen ersten Typ oder einen zweiten Typ handelt, die voneinander verschieden sind, entsprechend den durch die Erfassungseinrichtung erfaßten charakteristischen Punkten; und Bilden der zum Durchführen einer Umwandlung der Bilddaten verwendeten Umwandlungstabelle durch Verwenden einer ersten Gruppe charakteristischer Punkte, falls das Bild vom ersten Typ ist, oder einer zweiten Gruppe charakteristischer Punkte, falls das Bild vom zweiten Typ ist, wobei sich die erste Gruppe charakteristischer Punkte zumindest teilweise von der zweiten Gruppe charakteristischer Punkte unterscheidet.

15. Verfahren nach Anspruch 14, und auf die Unterscheidung ansprechendes Bilden einer ersten Umwandlungstabelle, wenn als Bildtyp ein normales Bild unterschieden wurde, und einer zweiten Umwandlungstabelle, wenn als Bildtyp ein Umkehrbild unterschieden wurde.

16. Verfahren nach Anspruch 15, umfassend von den durch die Erfassungseinrichtung erfaßten charakteristischen Punkten abhängiges Unterscheiden, ob es sich bei dem Bildtyp um einen normalen Typ, einen Umkehrtyp oder einen Gradationstyp handelt, und Bilden einer dritten Umwandlungstabelle, in der das Verhältnis zwischen den Eingangsbilddaten und den Ausgangsdaten im wesentlichen linear ist, wenn als Bildtyp der Gradationstyp unterschieden wurde.

17. Verfahren nach einem der Ansprüche 14 bis 16, wobei das Histogramm durch Abtasten einer Helligkeitskomponente der Bilddaten und Speichern der Abtastdaten in einem Speicher (50) gebildet wird.

18. Verfahren nach einem der Ansprüche 14 bis 17, wobei die Umwandlungstabelle Helligkeitsdaten in Dichtedaten umwandelt.

19. Verfahren nach einem der Ansprüche 14 bis 18, wobei die charakteristischen Punkte hellste und dunkelste Pegel der auf dem Histogramm dargestellten Bilddaten enthalten.

20. Verfahren nach Anspruch 19, wobei die Unterscheidung bezüglich aller Spitzenwerte des Histogramms erfolgt, und die Spitzenwerte des Histogramms bestimmt werden durch sequentielles Überprüfen der Signalpegel und Kennzeichnen aller Signalpegel als Spitzenwerte, die größer oder gleich einem Spitzenwertunterscheidungsbezugswert sind.

21. Verfahren nach Anspruch 20, wobei diejenigen Spitzenwerte, die zur Unterscheidung dahingehend, ob das Vorlagenbild ein normales Bild ist oder nicht, herangezogen werden, einen den dunkelsten Signalpegel repräsentierenden ersten charakteristischen Punkt (Idark) und einen den dunkelsten Spitzenwert der als Hintergrundbereich des normalen Bilds erkannten Spitzenwerte repräsentierenden zweiten charakteristischen Punkt (rpeak) umfassen.

22. Verfahren nach Anspruch 20 oder Anspruch 21, wobei diejenigen Spitzenwerte, die zur Unterscheidung dahingehend, ob das Vorlagenbild ein Umkehrbild ist oder nicht, herangezogen werden, einen charakteristischen Punkt (Imax), dessen Signalpegel der maximalen Frequenz in dem Histogramm entspricht, und den zweiten charakteristischen Punkt umfassen.

23. Gerät nach einem der Ansprüche 14 bis 22, wobei die Bilddaten von einem Bildleser eingegeben werden, der eine Vorlage abtastet, um die Bilddaten zu erzeugen.

24. Verfahren nach Anspruch 22 oder Anspruch 23, wobei die Umwandlungstabelle durch eine Vorabtastoperation der Vorlage durch den Bildleser gebildet wird.

25. Verfahren nach einem der Ansprüche 14 bis 24, weiterhin umfassend Erzeugen eines Wiedergabebilds auf einem Medium basierend auf den umgewandelten Bilddaten.

Revendications

1. Appareil de traitement d'image, comprenant :

   des moyens d'entrée (1022) pour entrer des données d'image représentant un original ;
   des premiers moyens de formation (38) pour former un histogramme sur la base des données d'image ;
   des moyens de détection (1025) pour détecter des points de particularité (Imax, Imin, Ipeak, Idark, rpeak) de l'histogramme ;
   des seconds moyens de formation (1025) pour définir une table de transformation pour effectuer une transformation des données d'image ;
   des moyens de traitement (1023) pour traiter les données d'image en utilisant la table de transformation ;

   caractérisé en ce que

   lesdits seconds moyens de formation sont conçus pour discriminer, selon les points de particularité détectés par lesdits moyens de détection, si un type d'image d'un original représenté par des données d'image entrées est au moins d'un premier type ou d'un second type qui sont différents l'un de l'autre ; et pour former ladite table de transformation pour effectuer une transformation sur les données d'image en utilisant un premier jeu de points de particularité si l'image est du premier type, ou un second jeu de points de particularité si l'image est du second type, ledit premier jeu de points de particularité étant au moins partiellement différent dudit second jeu de points de particularité.

2. Appareil selon la revendication 1, dans lequel lesdits seconds moyens de formation sont conçus, en réponse à la discrimination du type d'image, pour former une première table de transformation lorsque le type d'image a été discriminé comme étant une image normale et pour former une seconde table de transformation lorsque le type d'image a été discriminé comme étant une image inverse.

3. Appareil selon la revendication 2, dans lequel lesdits seconds moyens de formation sont conçus pour discriminer, selon des points de particularité détectés par lesdits moyens de détection, si le type d'image est un type normal, un type inverse ou un type gradation, et pour former une troisième table de transformation dans laquelle la relation entre les données d'image d'entrée et les données de sortie est sensiblement linéaire lorsque l'on discrimine que le type d'image est le type gradation.

4. Appareil selon l'une quelconque des revendications précédentes, dans lequel lesdits premiers moyens de formation forment l'histogramme en échantillonnant une composante de luminance desdites données d'image et en mémorisant les données échantillonnées dans une mémoire (50).

5. Appareil selon l'une quelconque des revendications précédentes, dans lequel ladite table de transformation transforme les données de luminance en données de densité.

6. Appareil selon l'une quelconque des revendications précédentes, dans lequel lesdits points de particularité comprennent le niveau le plus lumineux et le niveau le plus sombre des données d'image, comme le représente l'histogramme.

7. Appareil selon la revendication 6, dans lequel les seconds moyens de formation sont conçus pour exécuter une discrimination sur tous les pics de l'histogramme.

8. Appareil selon la revendication 7, dans lequel les pics dans l'histogramme sont déterminés en vérifiant de manière séquentielle les niveaux de signal et en désignant comme pics chaque niveau de signal qui est égal ou supérieur à une valeur de référence de discrimination de pic.

9. Appareil selon la revendication 8, dans lequel les valeurs de pics utilisées pour discriminer si l'image formant original est ou non une image normale comprennent un premier point de particularité (Idark) représentant le niveau de signal le plus sombre, et un second point de particularité (rpeak) représentant le pic le plus sombre des pics reconnus comme étant des pics de la partie d'arrière-plan de l'image normale.

10. Appareil selon la revendication 8 ou la revendication 9, dans lequel les valeurs de pics utilisées pour discriminer si l'image formant original est ou non une image inverse comprennent un point de particularité (Imax) dont le niveau

de signal correspond à la fréquence maximale dans l'histogramme et ledit second point de particularité.

11. Appareil selon l'une quelconque des revendications précédentes, dans lequel lesdits moyens d'entrée sont constitués par un dispositif de lecture d'image pour scanner un original et pour produire les données d'image.

12. Appareil selon la revendication 11, dans lequel lesdits seconds moyens de formation sont conçus pour former la table de transformation lorsque ledit dispositif de lecture d'image effectue une opération de préscannage sur ledit original.

13. Appareil selon l'une quelconque des revendications précédentes, comprenant de plus des moyens de formation d'image pour former une image de reproduction sur un support sur la base des données d'image sorties à partir desdits moyens de traitement.

14. Procédé de traitement d'image comprenant :

l'entrée de données d'image représentant un original ;
la formation d'un histogramme sur la base des données d'image ;
la détection de points de particularité (Imax, Imin, Ipeak, Idark, rpeak) de l'histogramme ;
la définition d'une table de transformation pour effectuer une transformation sur les données d'image ; et
le traitement des données d'image en utilisant la table de transformation ;

caractérisé par

selon des points de particularité détectés par lesdits moyens de détection, le fait de discriminer si un type d'image d'un original représenté par les données d'image entrées est au moins d'un premier type ou d'un second type qui sont différents l'un de l'autre ; et par la formation de la table de transformation pour effectuer une transformation sur les données d'image en utilisant un premier jeu de points de particularité si l'image est du premier type, ou un second jeu de points de particularité si l'image est du second type, ledit premier jeu de points de particularité étant au moins partiellement différent dudit second jeu de points de particularité.

15. Procédé selon la revendication 14, et en réponse à la discrimination du type d'image, la formation d'une première table de transformation lorsque l'on a discriminé que le type d'image est une image normale et d'une seconde table de transformation lorsque l'on a discriminé que le type d'image est une image inverse.

16. Procédé selon la revendication 15, comprenant la discrimination, selon des points de particularité détectés, si le type d'image est un type normal, un type inverse ou un type gradation, et la formation d'une troisième table de transformation dans laquelle la relation entre les données d'image d'entrée et les données de sortie est sensiblement linéaire lorsque l'on détermine que le type d'image est le type gradation.

17. Procédé selon l'une quelconque des revendications 14 à 16, dans lequel l'histogramme est formé en échantillonnant une composante de luminance desdites données d'image et en mémorisant les données échantillonnées dans une mémoire (50).

18. Procédé selon l'une quelconque des revendications 14 à 17, dans lequel ladite table de transformation transforme les données de luminance en données de densité.

19. Procédé selon l'une quelconque des revendications 14 à 18, dans lequel lesdits points de particularité comprennent le niveau le plus lumineux et le niveau le plus sombre des données d'image, comme le représente l'histogramme.

20. Procédé selon la revendication 19, dans lequel la discrimination est exécutée sur tous les pics de l'histogramme et les pics dans l'histogramme sont déterminés en vérifiant de manière séquentielle les niveaux de signal et en désignant comme pics chaque niveau de signal qui est égal ou supérieur à une valeur de référence de discrimination de pic.

21. Procédé selon la revendication 20, dans lequel les valeurs de pics utilisées pour discriminer si l'image formant original est ou non une image normale comprennent un premier point de particularité (Idark) représentant le niveau de signal le plus sombre, et un second point de particularité (rpeak) représentant le pic le plus sombre des pics reconnus comme étant des pics de la partie d'arrière-plan de l'image normale.

22. Procédé selon la revendication 20 ou la revendication 21, dans lequel les valeurs de pics utilisées pour discriminer si l'image formant original est ou non une image inverse comprennent un point de particularité (Imax) dont le niveau de signal correspond à la fréquence maximale dans l'histogramme et ledit second point de particularité.

23. Procédé selon l'une quelconque des revendications 14 à 22, dans lequel lesdites données d'image sont entrées à partir d'un dispositif de lecture d'image qui scanne un original pour produire les données d'image.

24. Procédé selon la revendication 22 ou la revendication 23, dans lequel la table de transformation est formée par ledit dispositif de lecture d'image effectuant une opération de préscannage sur ledit original.

25. Procédé selon l'une quelconque des revendications 14 à 24, comprenant de plus la formation d'une image de reproduction sur un support sur la base des données d'image transformées.

FIG. 1

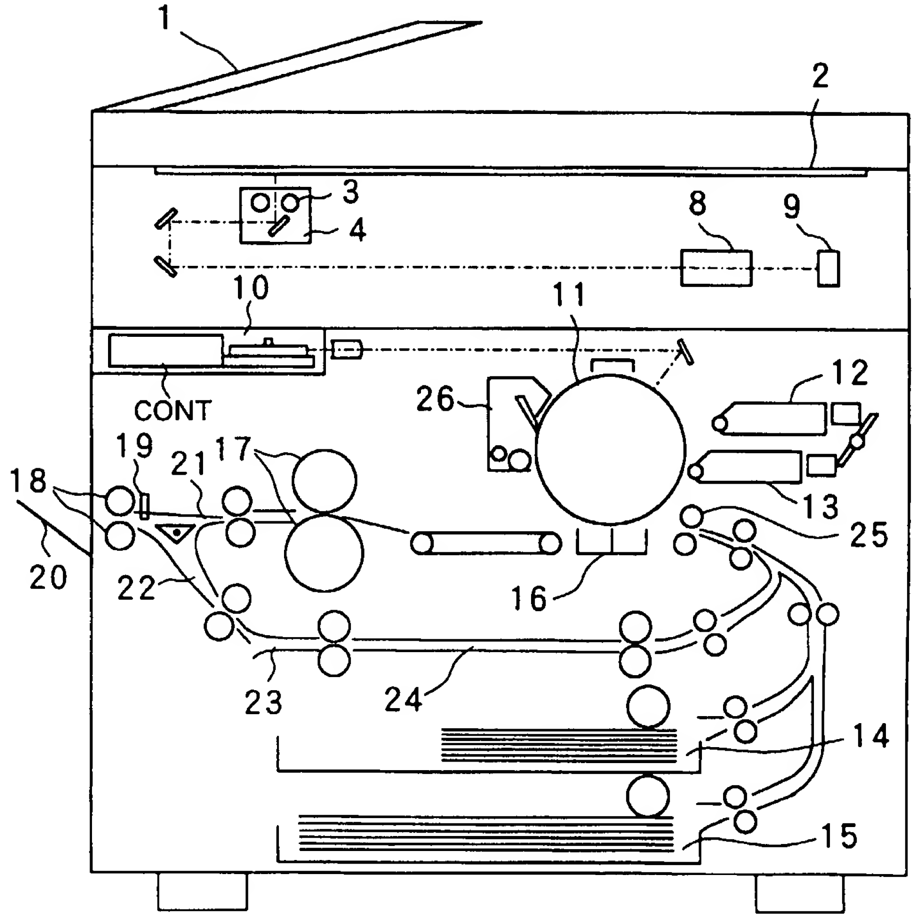


FIG. 2

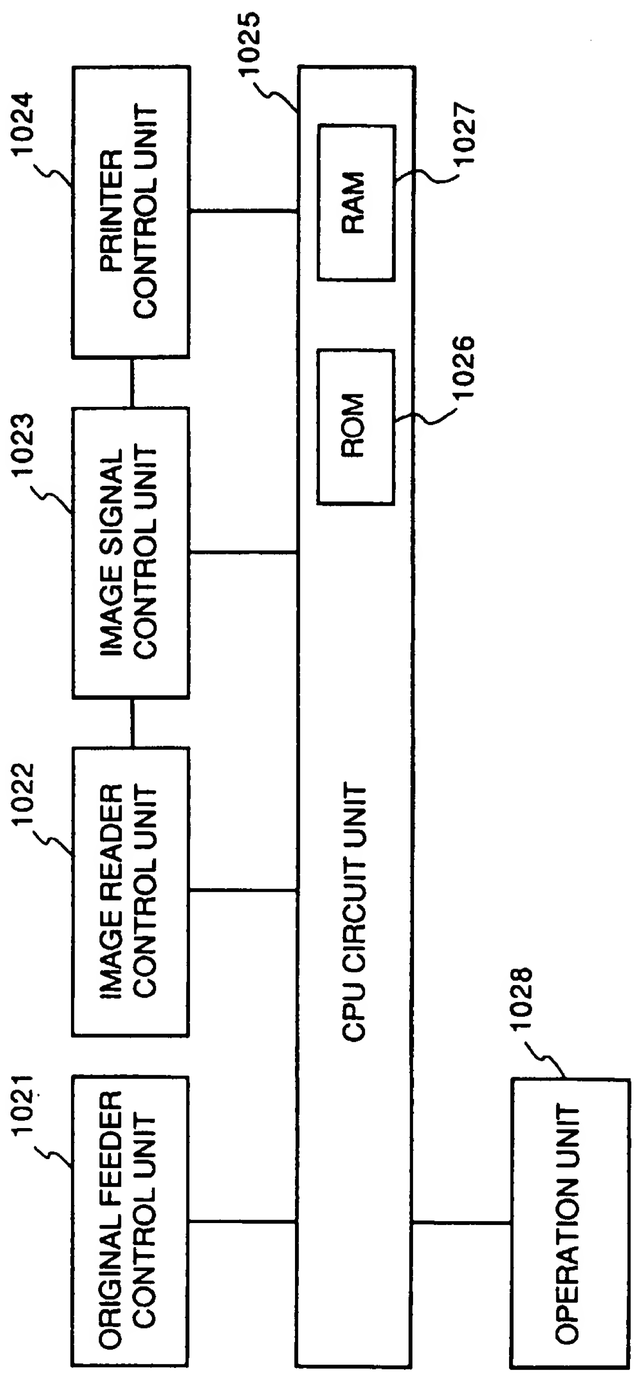

1024
PRINTER CONTROL UNIT
1023
IMAGE SIGNAL CONTROL UNIT
1022
IMAGE READER CONTROL UNIT
1021
ORIGINAL FEEDER CONTROL UNIT
1025
1027
RAM
1026
ROM
CPU CIRCUIT UNIT
1028
OPERATION UNIT

FIG. 3

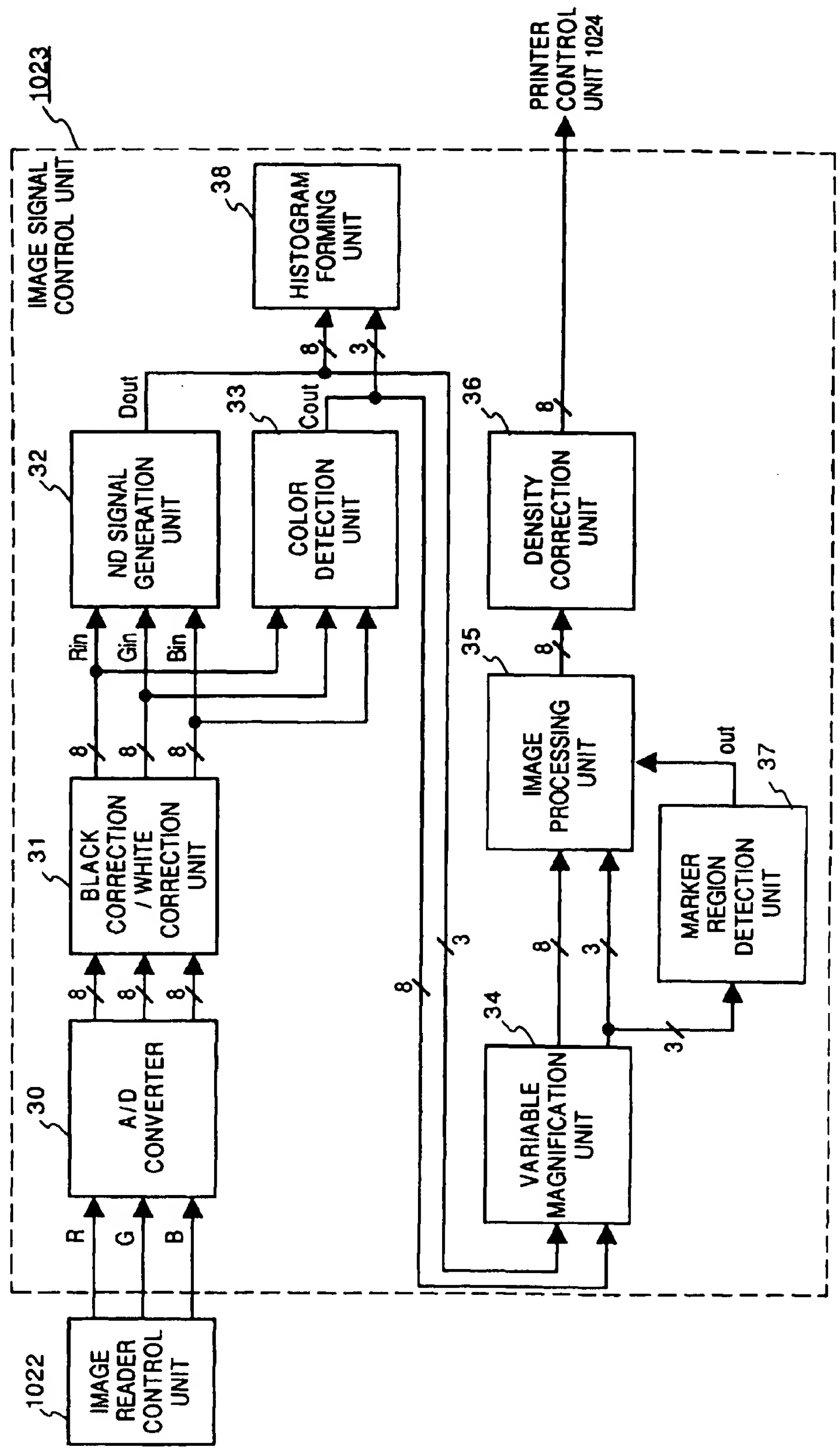

1023
IMAGE SIGNAL CONTROL UNIT
1022
IMAGE READER CONTROL UNIT
R
G
B
30
A/D CONVERTER
31
BLACK CORRECTION / WHITE CORRECTION UNIT
Rin
Gin
Bin
32
ND SIGNAL GENERATION UNIT
Dout
33
COLOR DETECTION UNIT
Cout
38
HISTOGRAM FORMING UNIT
34
VARIABLE MAGNIFICATION UNIT
35
IMAGE PROCESSING UNIT
36
DENSITY CORRECTION UNIT
37
MARKER REGION DETECTION UNIT
out
PRINTER CONTROL UNIT 1024

FIG. 4

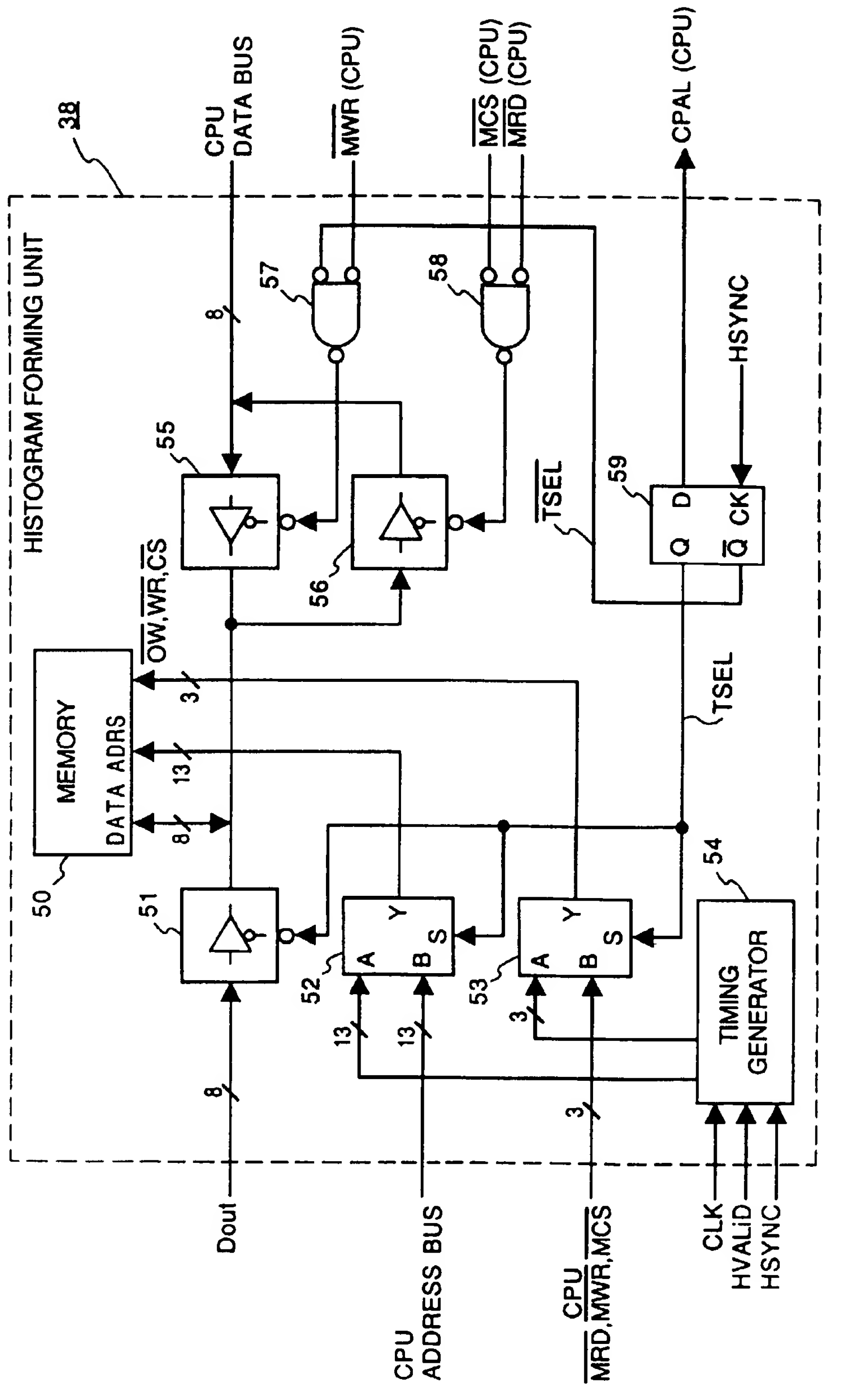
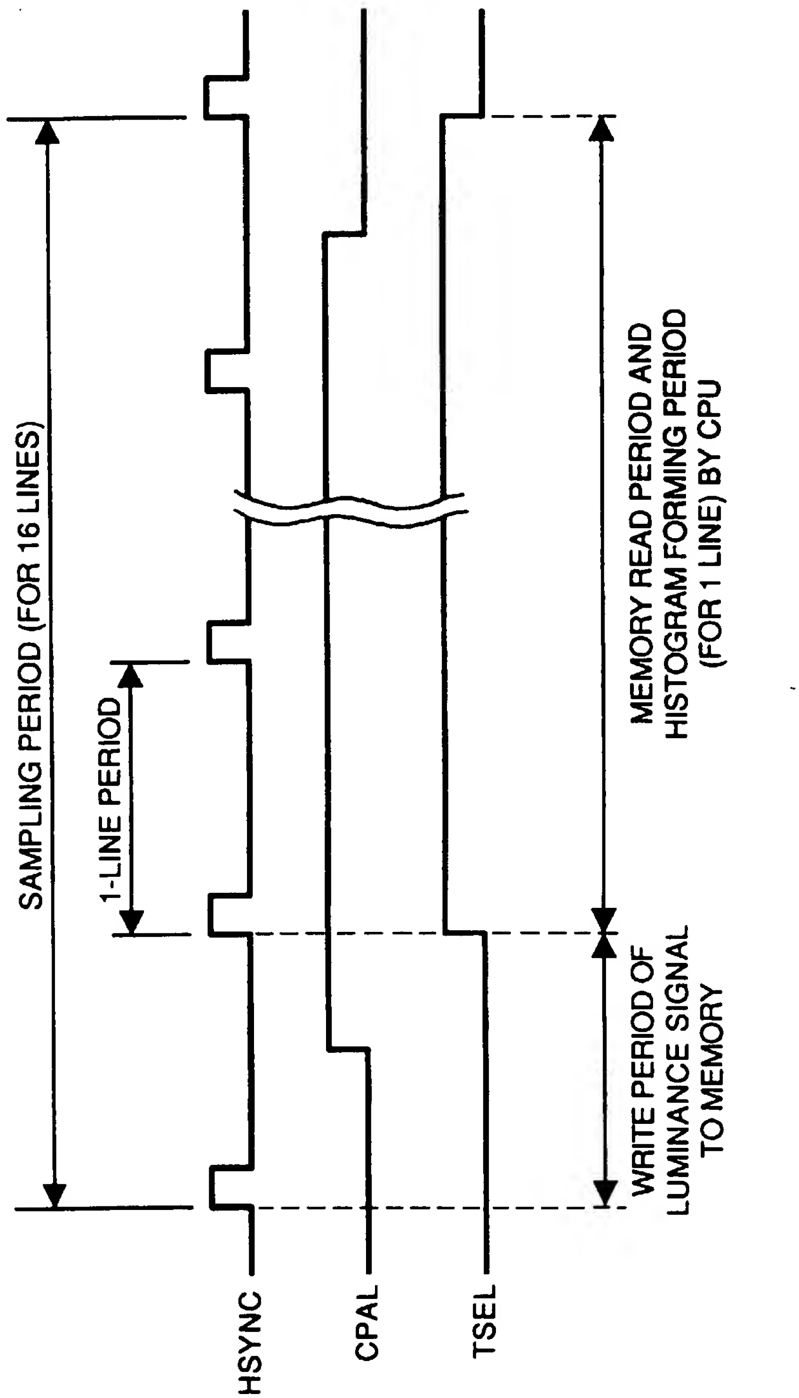

38
HISTOGRAM FORMING UNIT
CPU DATA BUS
MWR (CPU)
MCS (CPU)
MRD (CPU)
CPAL (CPU)
HSYNC
TSEL
TSEL
57
58
55
56
59
D
Q
CK
Q
OW,WR,CS
MEMORY
DATA ADRS
50
51
52
53
54
A
B
Y
S
TIMING GENERATOR
8
8
8
3
13
13
13
3
3
Dout
CPU ADDRESS BUS
CPU MRD,MWR,MCS
CLK
HVALID
HSYNC

FIG. 5


SAMPLING PERIOD (FOR 16 LINES)
1-LINE PERIOD
HSYNC
CPAL
TSEL
WRITE PERIOD OF LUMINANCE SIGNAL TO MEMORY
MEMORY READ PERIOD AND HISTOGRAM FORMING PERIOD (FOR 1 LINE) BY CPU

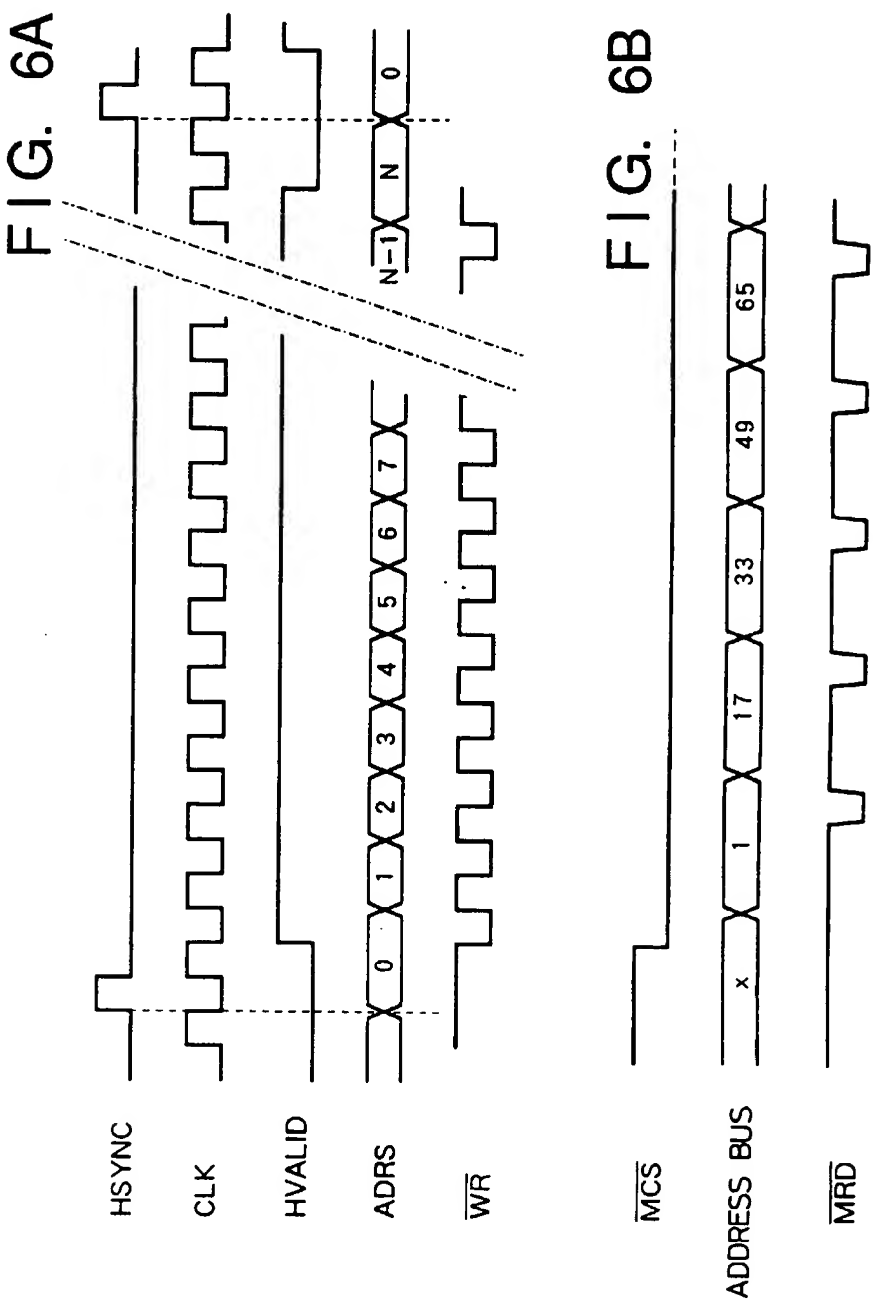

HSYNC
CLK
HVALID
ADRS
0 1 2 3 4 5 6 7 N-1 N 0
WR
MCS
ADDRESS BUS
x 1 17 33 49 65
MRD

FIG. 6A

FIG. 6B

FIG. 7A

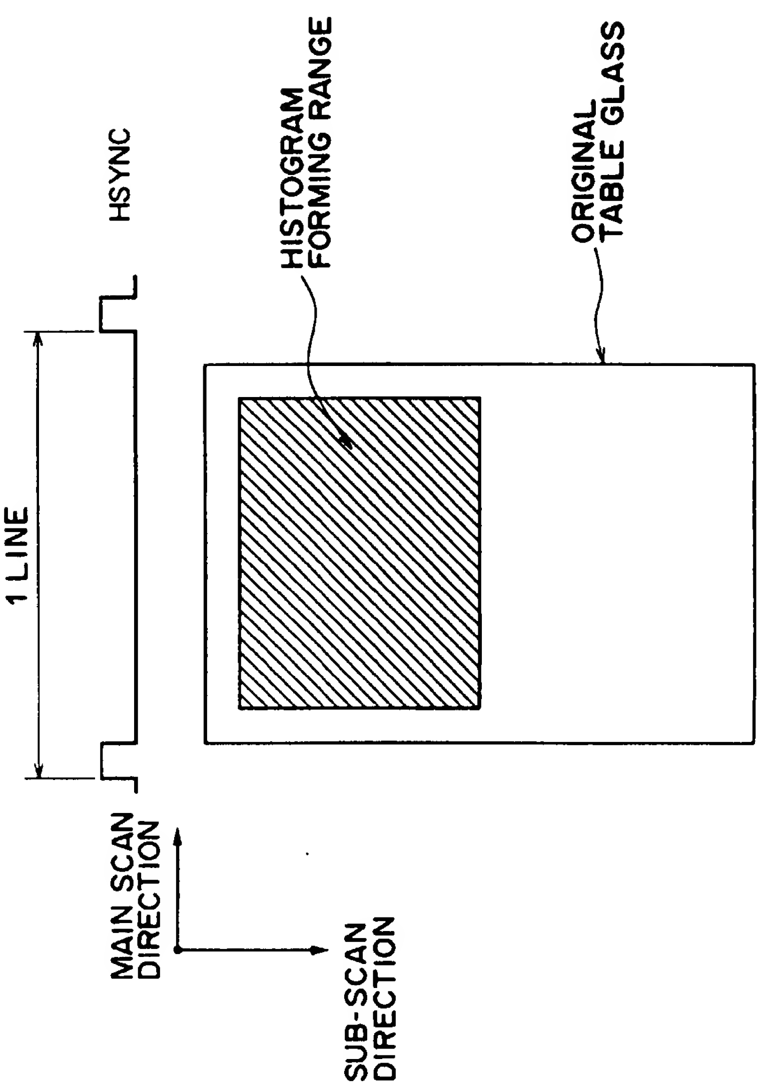

HSYNC
1 LINE
HISTOGRAM FORMING RANGE
ORIGINAL TABLE GLASS
MAIN SCAN DIRECTION
SUB-SCAN DIRECTION

FIG. 7B

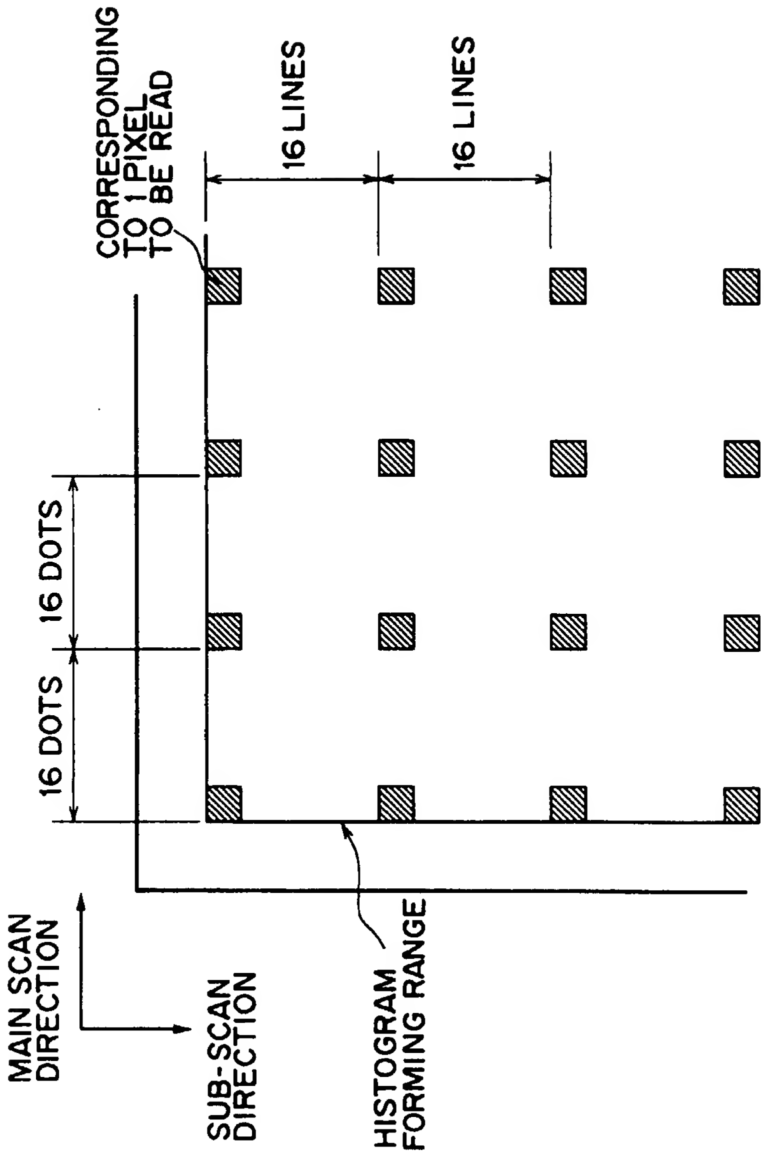

CORRESPONDING TO 1 PIXEL TO BE READ
16 LINES
16 LINES
16 DOTS
16 DOTS
MAIN SCAN DIRECTION
SUB-SCAN DIRECTION
HISTOGRAM FORMING RANGE

FIG. 8

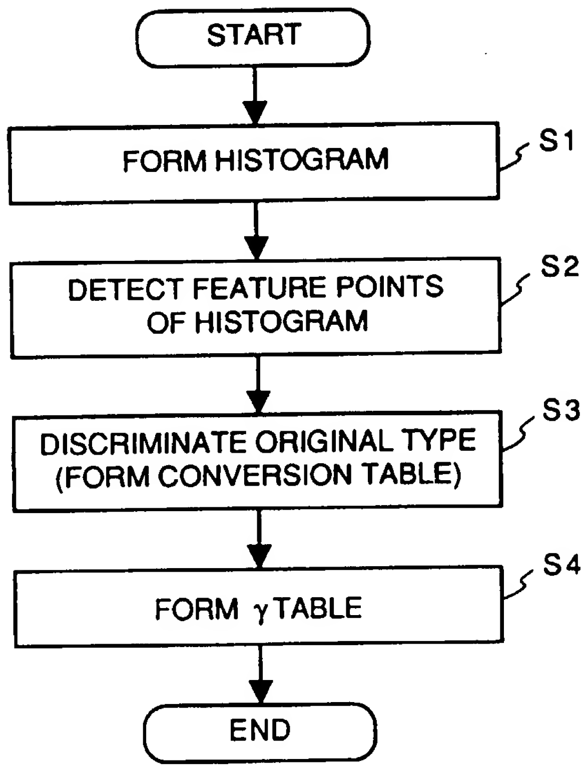

START
FORM HISTOGRAM
S1
DETECT FEATURE POINTS OF HISTOGRAM
S2
DISCRIMINATE ORIGINAL TYPE (FORM CONVERSION TABLE)
S3
FORM γTABLE
S4
END

FIG. 9

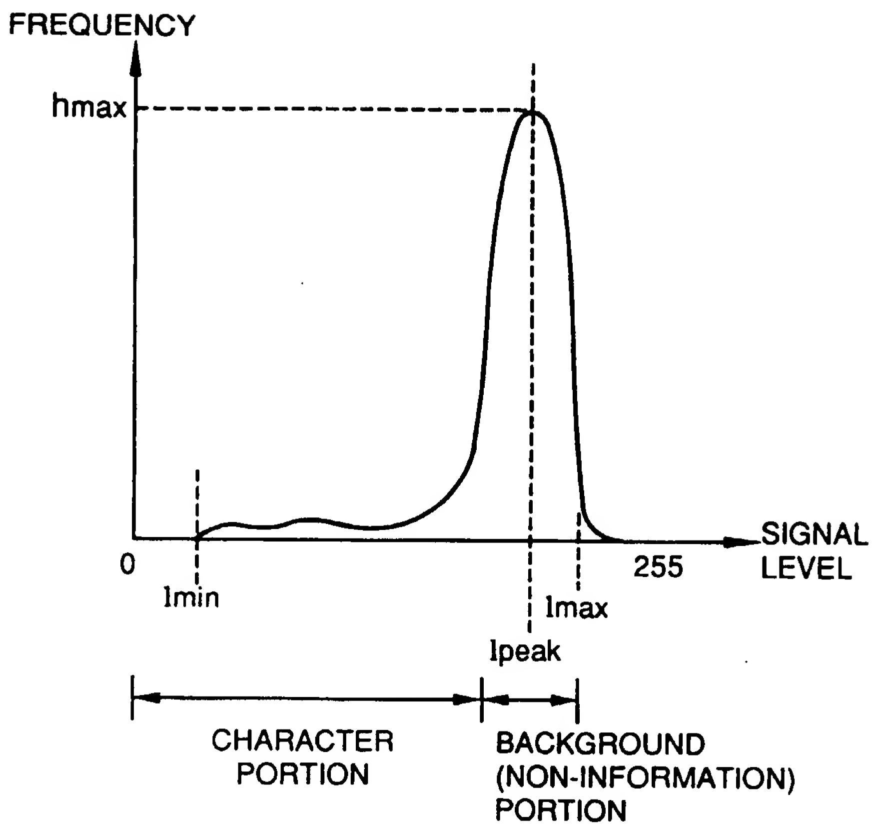

FREQUENCY
hmax
0
lmin
lpeak
lmax
255
SIGNAL LEVEL
CHARACTER PORTION
BACKGROUND (NON-INFORMATION) PORTION

FIG. 10

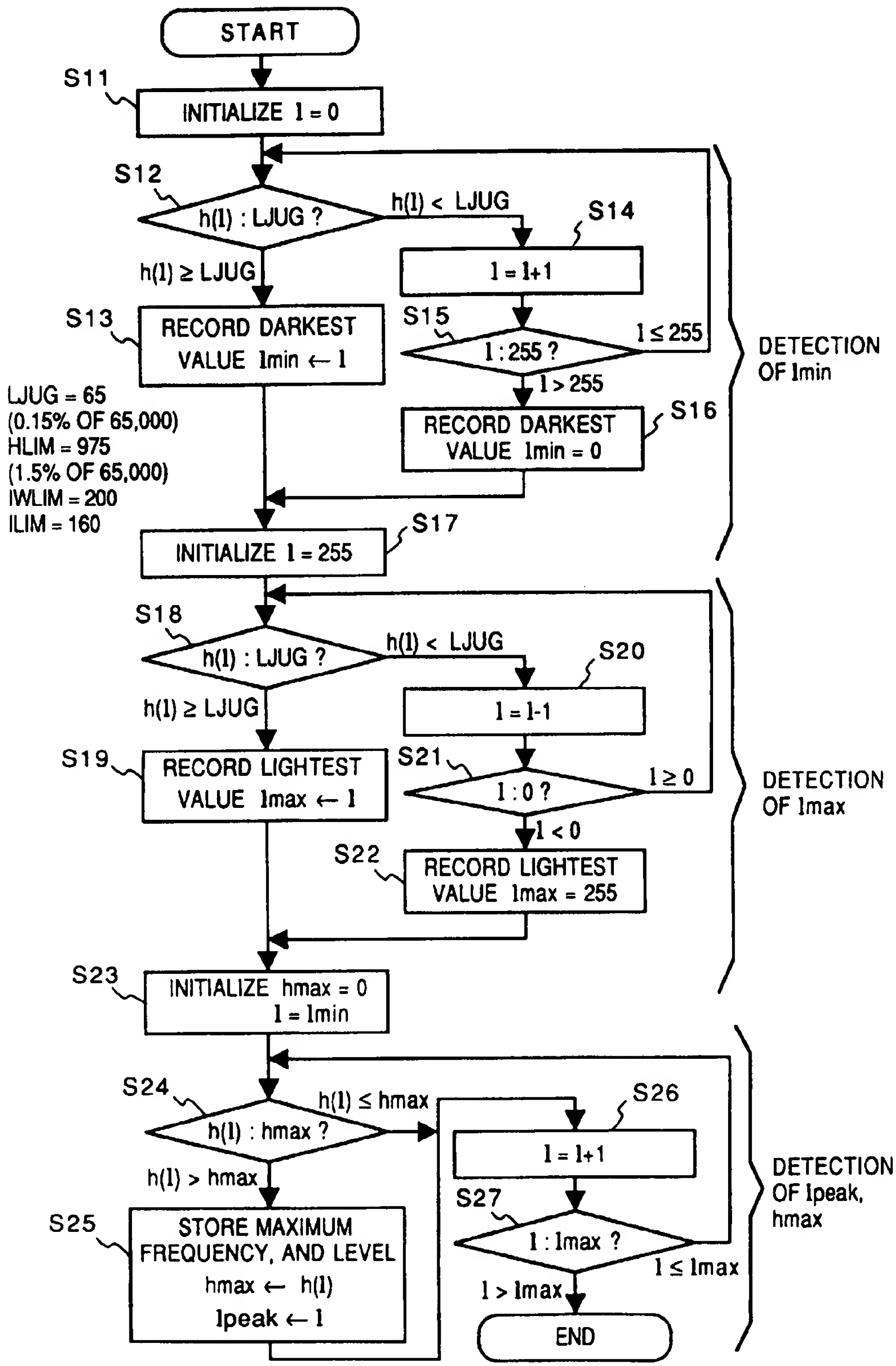

START
S11
INITIALIZE l = 0
S12
h(l) : LJUG ?
h(l) < LJUG
S14
l = l+1
h(l) ≥ LJUG
S13
RECORD DARKEST VALUE lmin ← l
S15
l : 255 ?
l ≤ 255
l > 255
S16
RECORD DARKEST VALUE lmin = 0
DETECTION OF lmin
LJUG = 65
(0.15% OF 65,000)
HLIM = 975
(1.5% OF 65,000)
IWLIM = 200
ILIM = 160
S17
INITIALIZE l = 255
S18
h(l) : LJUG ?
h(l) < LJUG
S20
l = l-1
h(l) ≥ LJUG
S19
RECORD LIGHTEST VALUE lmax ← l
S21
l : 0 ?
l ≥ 0
l < 0
S22
RECORD LIGHTEST VALUE lmax = 255
DETECTION OF lmax
S23
INITIALIZE hmax = 0
l = lmin
S24
h(l) : hmax ?
h(l) ≤ hmax
S26
l = l+1
h(l) > hmax
S25
STORE MAXIMUM FREQUENCY, AND LEVEL
hmax ← h(l)
lpeak ← l
S27
l : lmax ?
l ≤ lmax
l > lmax
END
DETECTION OF lpeak, hmax

FIG. 11

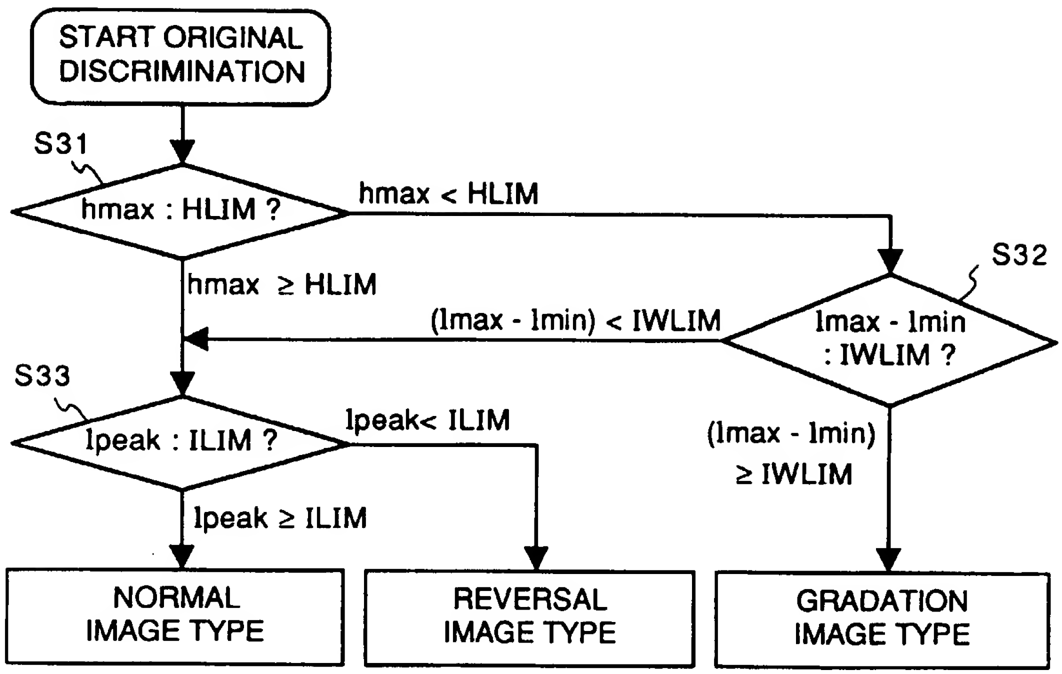
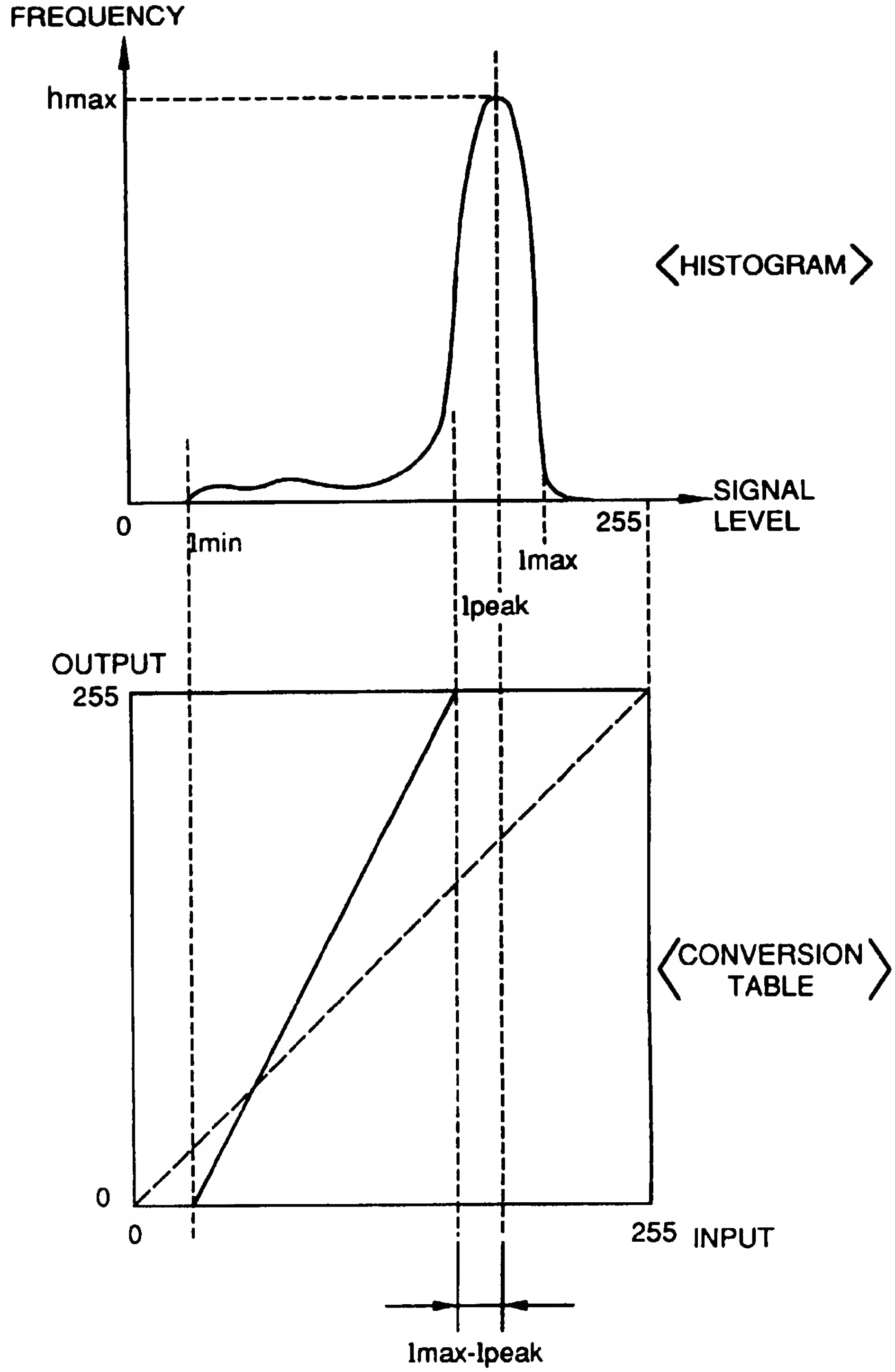
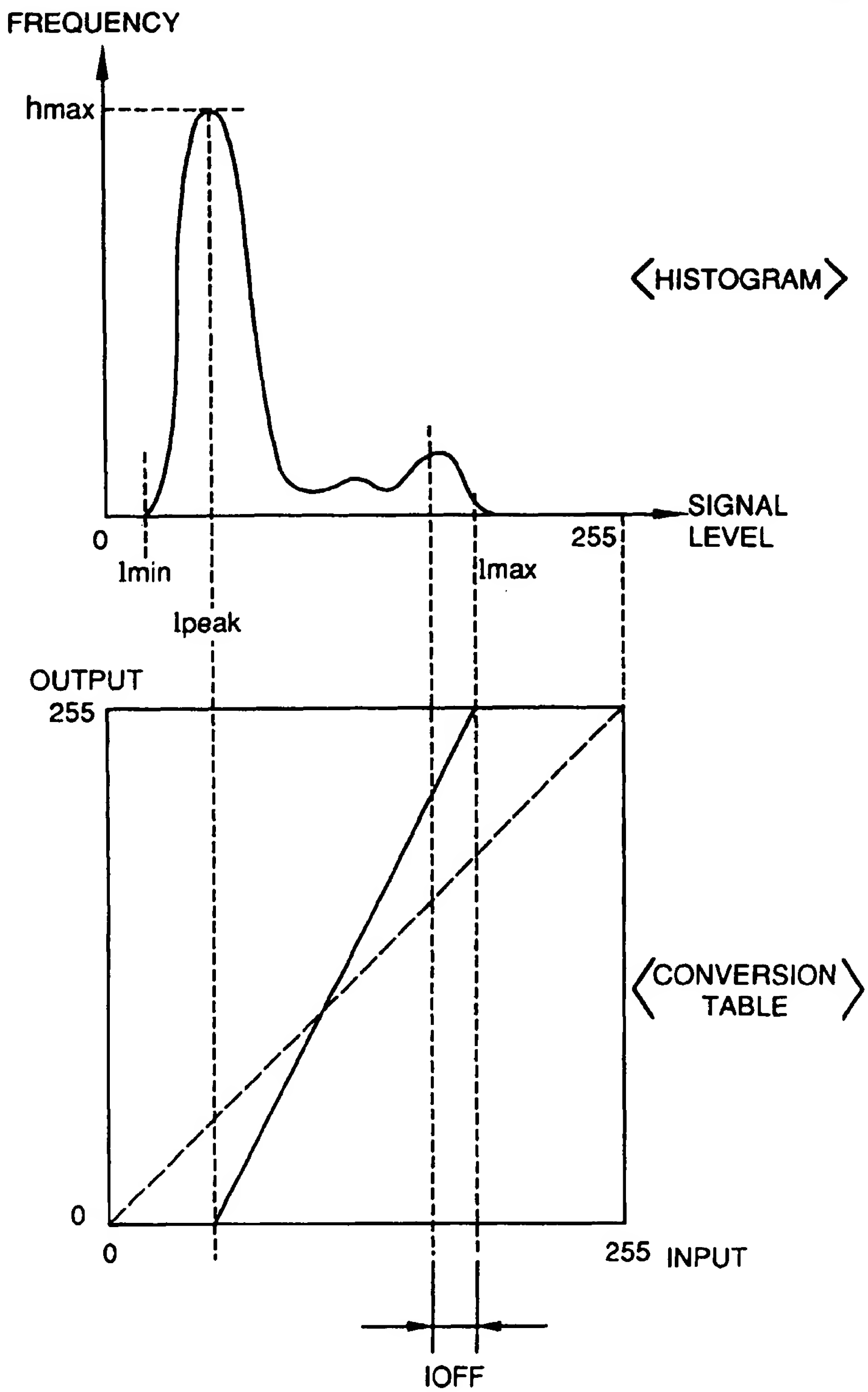

START ORIGINAL DISCRIMINATION
S31
hmax : HLIM ?
hmax < HLIM
hmax ≥ HLIM
S32
lmax - lmin : IWLIM ?
(lmax - lmin) < IWLIM
(lmax - lmin) ≥ IWLIM
S33
lpeak : ILIM ?
lpeak< ILIM
lpeak ≥ ILIM
NORMAL IMAGE TYPE
REVERSAL IMAGE TYPE
GRADATION IMAGE TYPE

FIG. 12



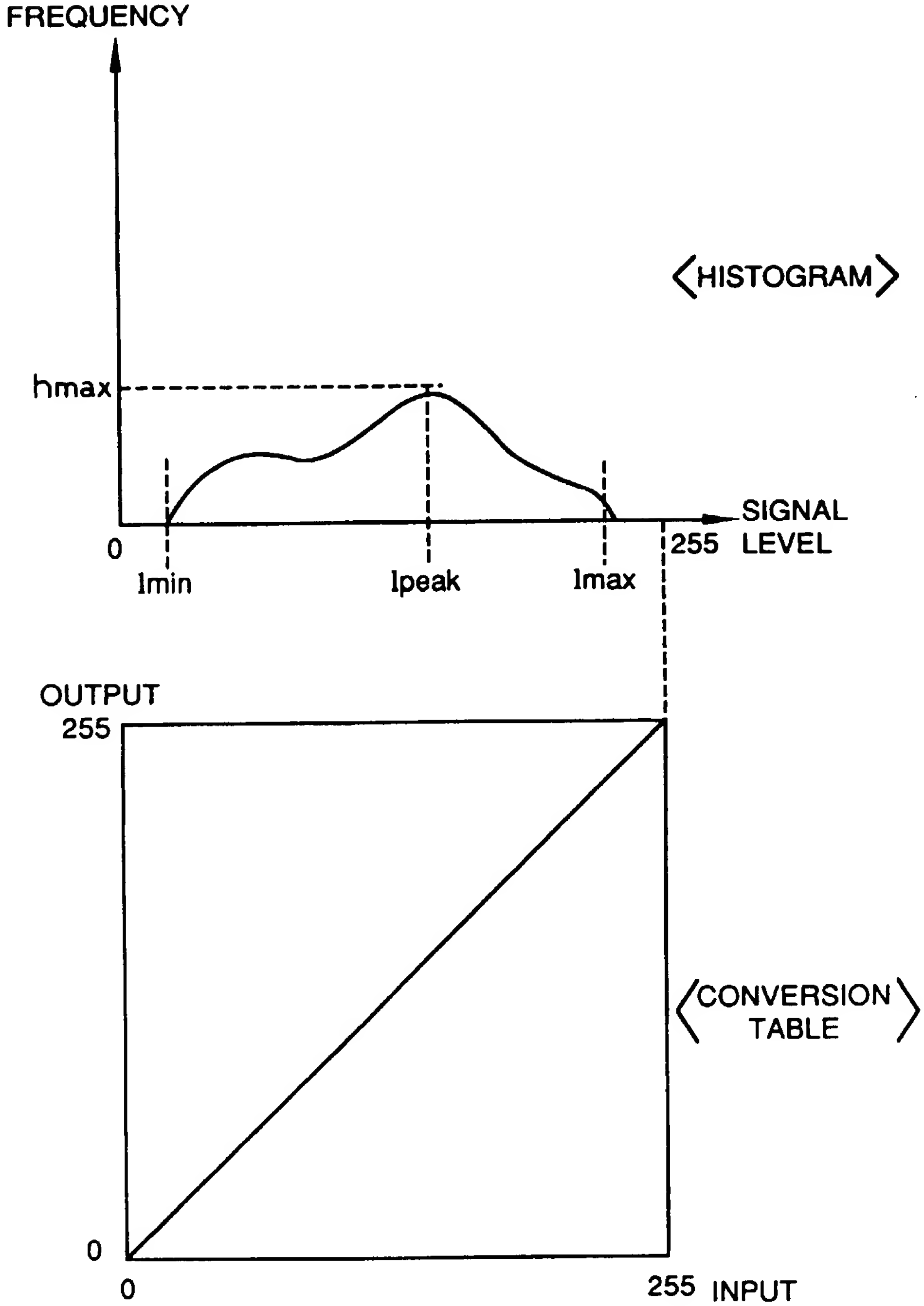
NORMAL IMAGE TYPE

FIG. 13



REVERSAL IMAGE TYPE

FIG. 14



GRADATION IMAGE TYPE

FIG. 15A

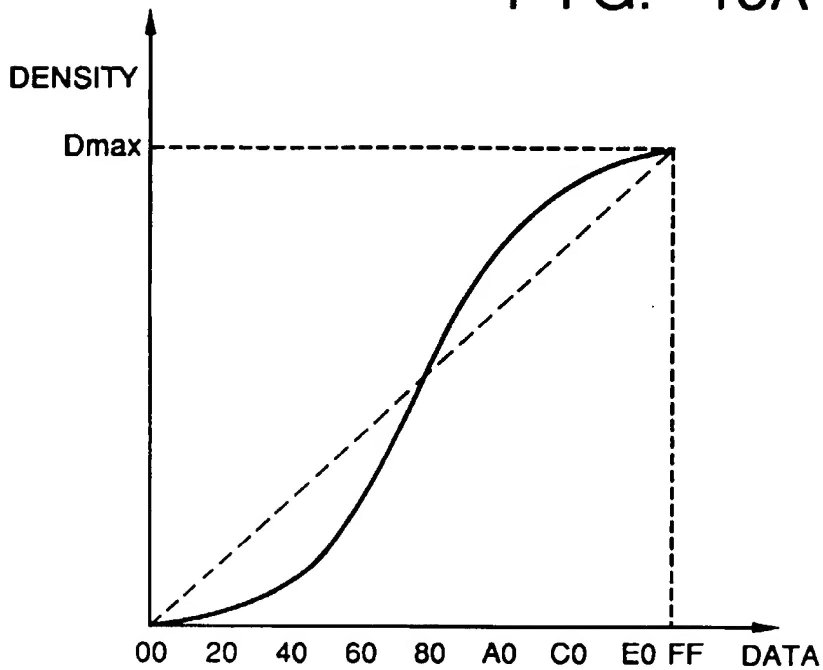


FIG. 15B

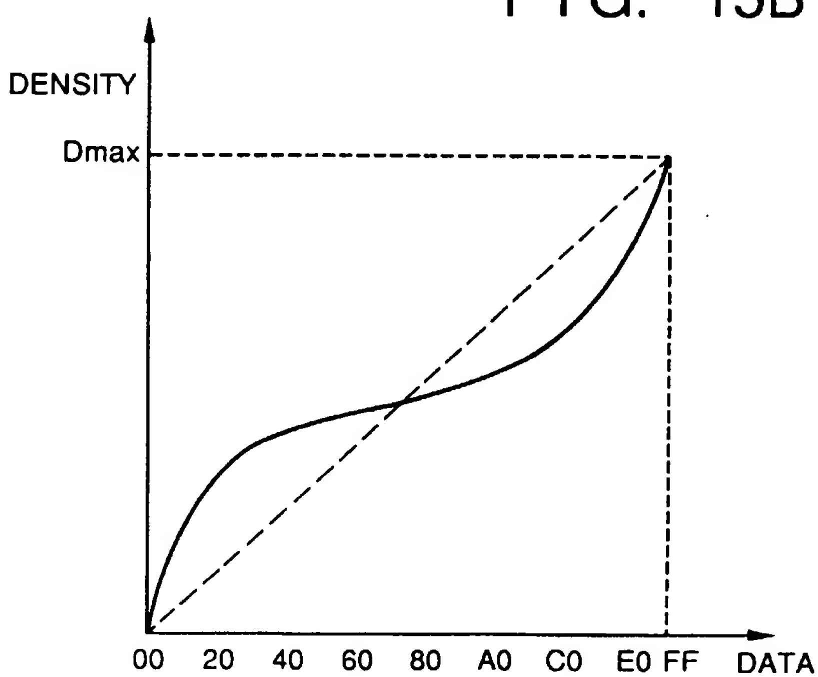


FIG. 16

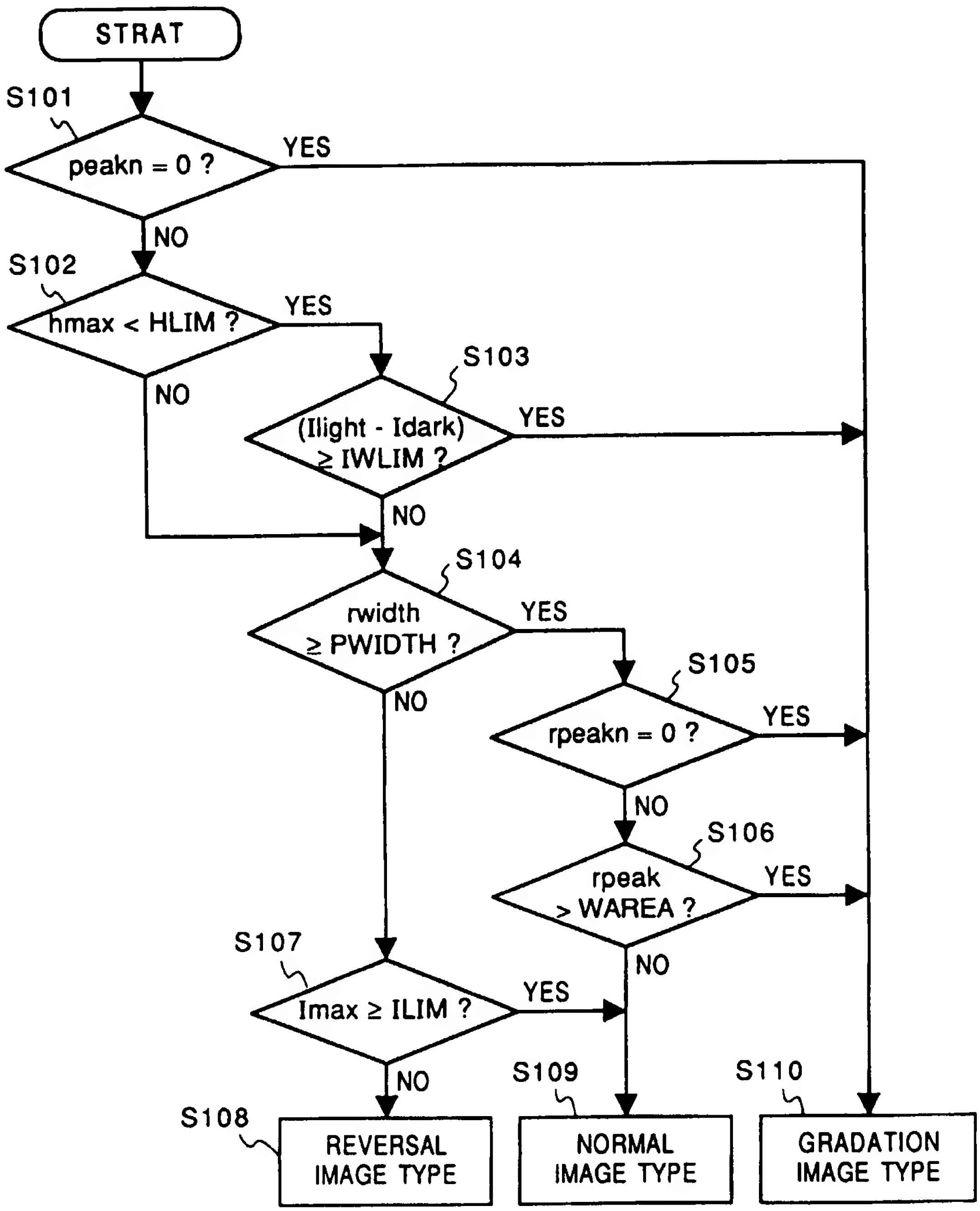

STRAT
S101
peakn = 0 ?
YES
NO
S102
hmax < HLIM ?
YES
NO
S103
(Ilight - Idark) ≥ IWLIM ?
YES
NO
S104
rwidth ≥ PWIDTH ?
YES
NO
S105
rpeakn = 0 ?
YES
NO
S106
rpeak > WAREA ?
YES
NO
S107
Imax ≥ ILIM ?
YES
NO
S108
REVERSAL IMAGE TYPE
S109
NORMAL IMAGE TYPE
S110
GRADATION IMAGE TYPE

FIG. 17

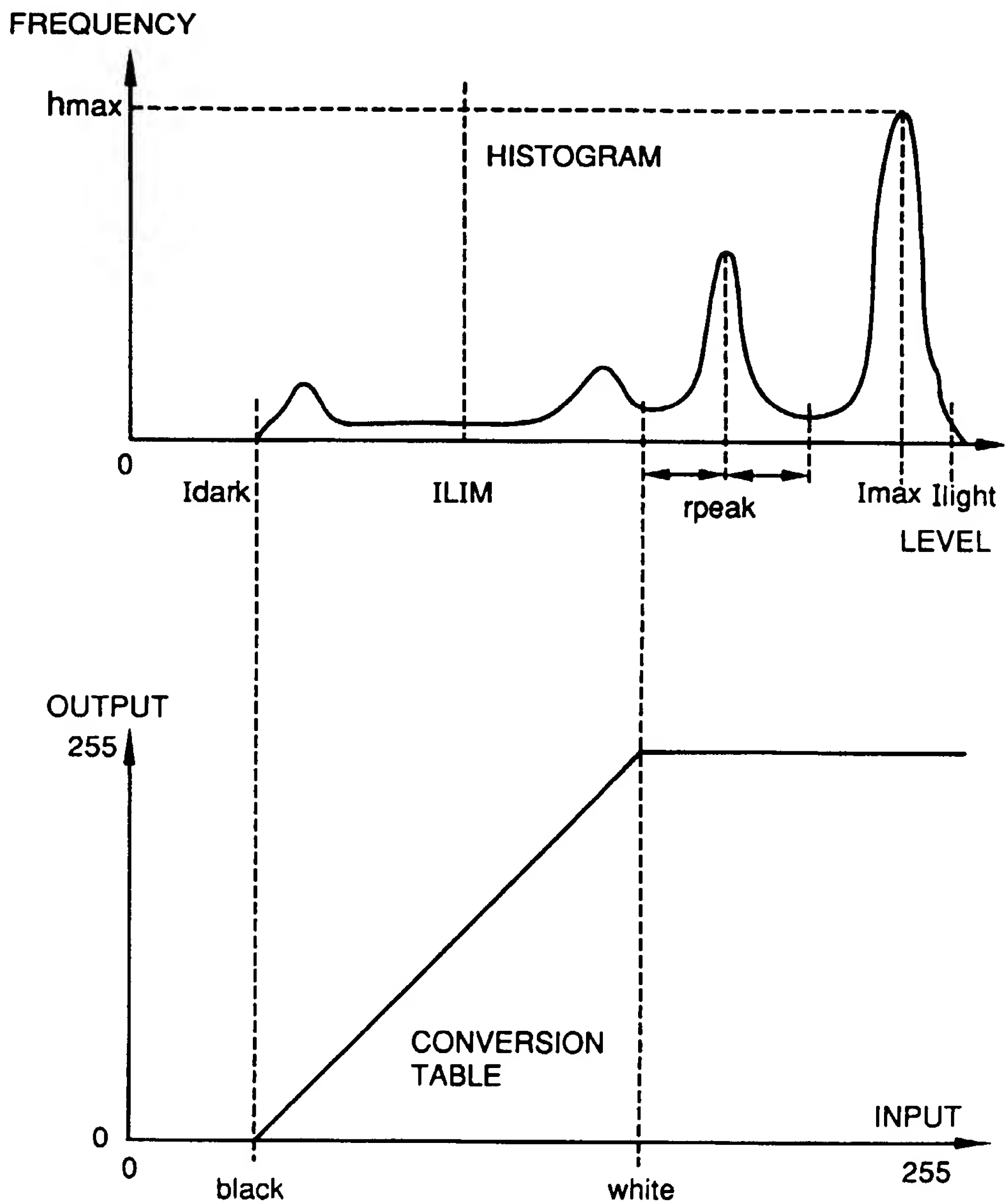

FREQUENCY
hmax
HISTOGRAM
0
Idark
ILIM
rpeak
Imax
Ilight
LEVEL
OUTPUT
255
CONVERSION
TABLE
INPUT
0
0
black
white
255

FIG. 18

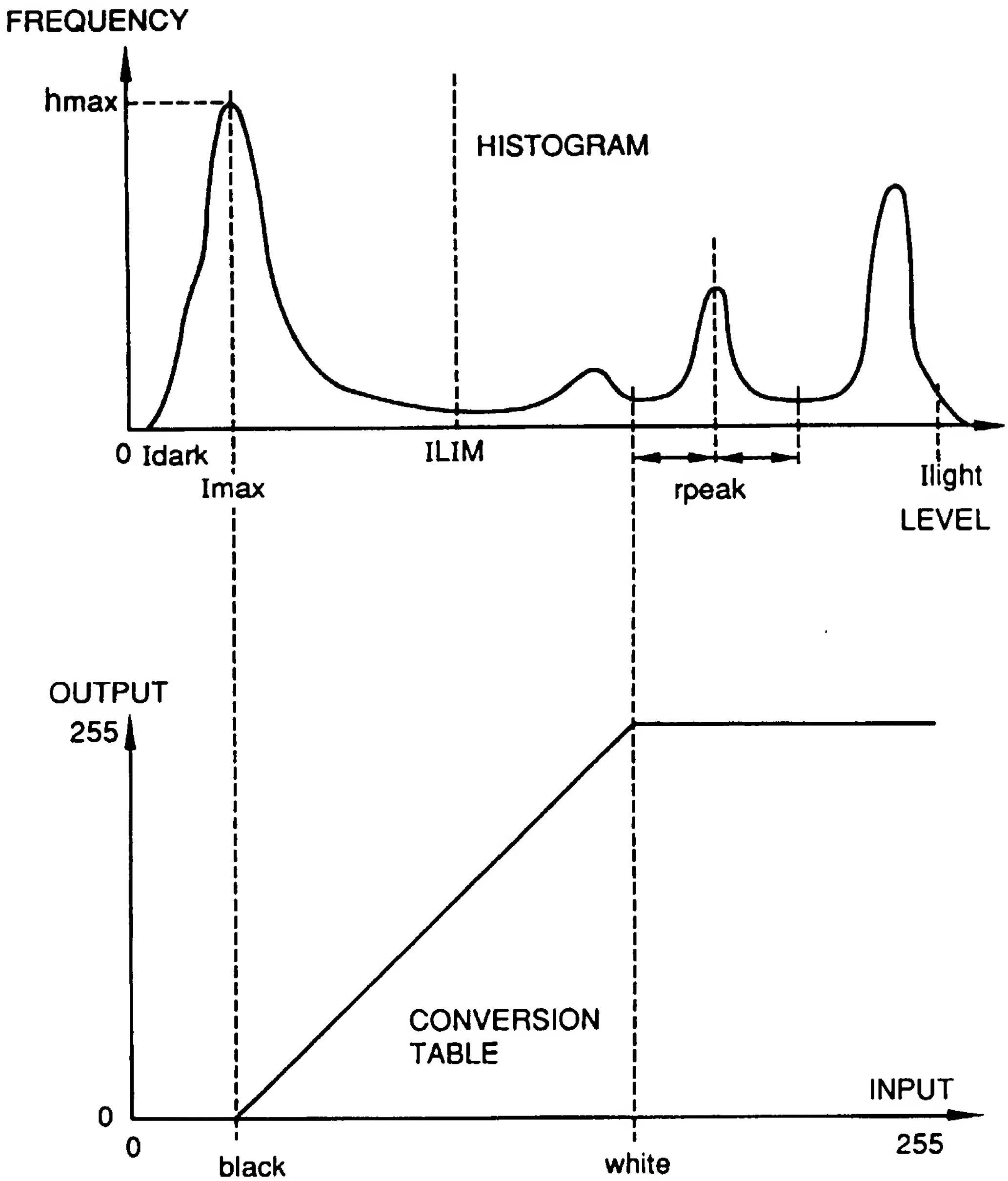

FREQUENCY
hmax
HISTOGRAM
0 Idark
Imax
ILIM
rpeak
Ilight
LEVEL
OUTPUT
255
CONVERSION
TABLE
INPUT
0
0
black
white
255

FIG. 19

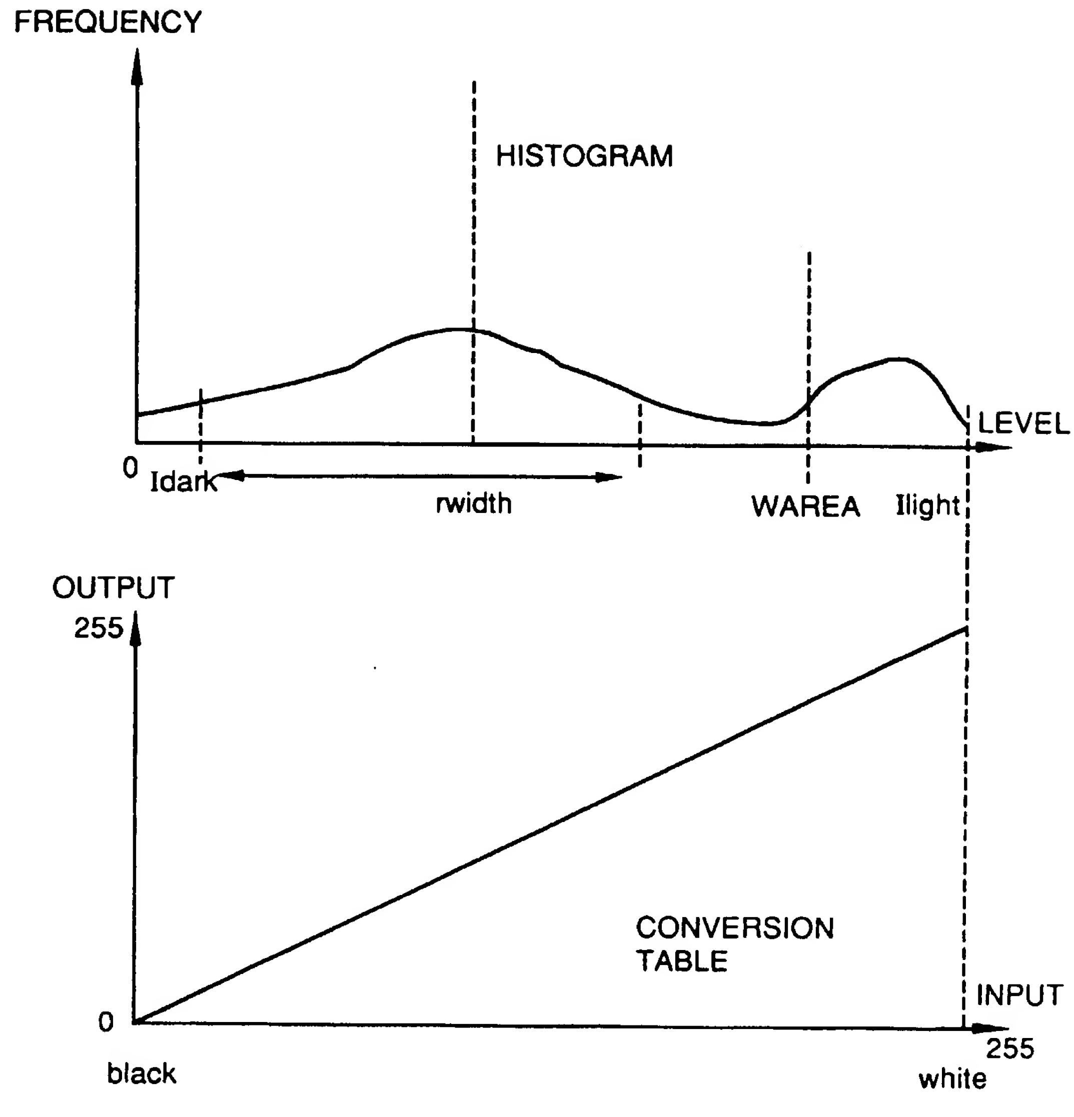

FREQUENCY
HISTOGRAM
LEVEL
0
Idark
rwidth
WAREA
Ilight
OUTPUT
255
CONVERSION
TABLE
INPUT
0
black
255
white

FIG. 20

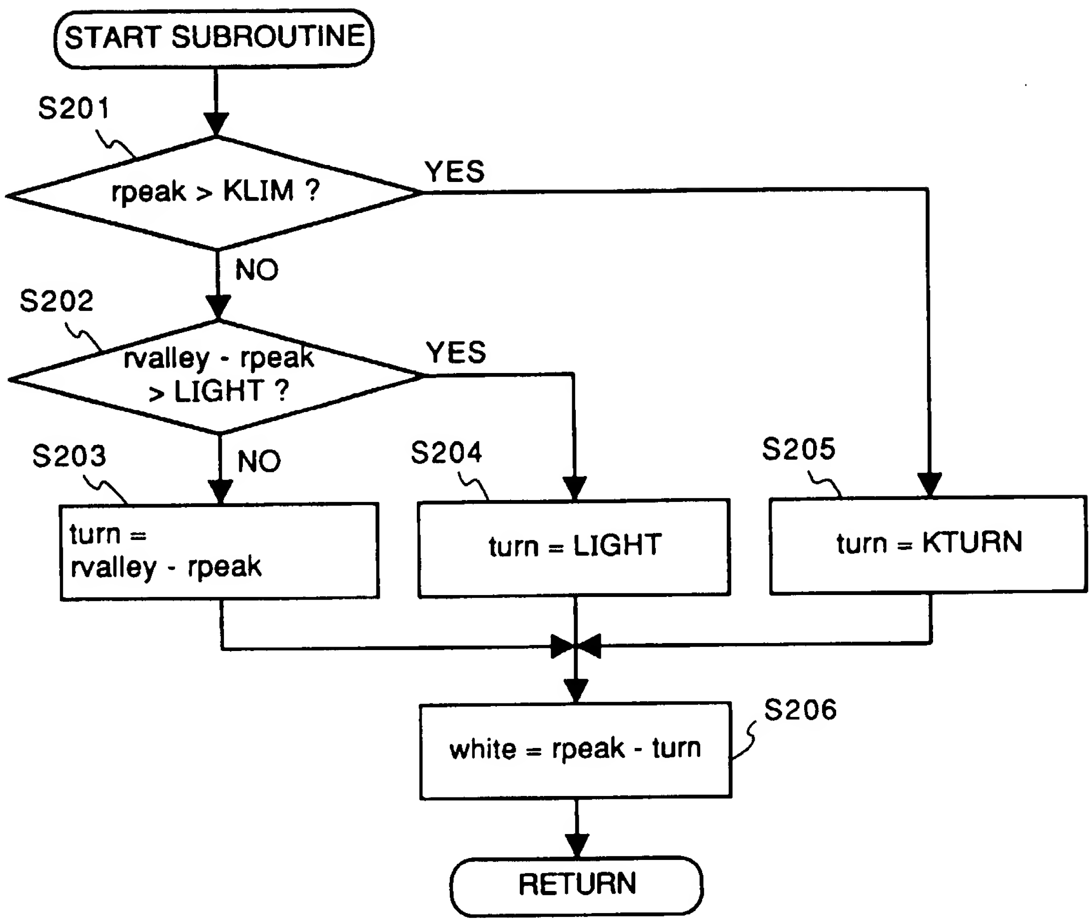

START SUBROUTINE
S201
rpeak > KLIM ?
YES
NO
S202
rvalley - rpeak > LIGHT ?
YES
NO
S203
turn = rvalley - rpeak
S204
turn = LIGHT
S205
turn = KTURN
S206
white = rpeak - turn
RETURN

FIG. 21

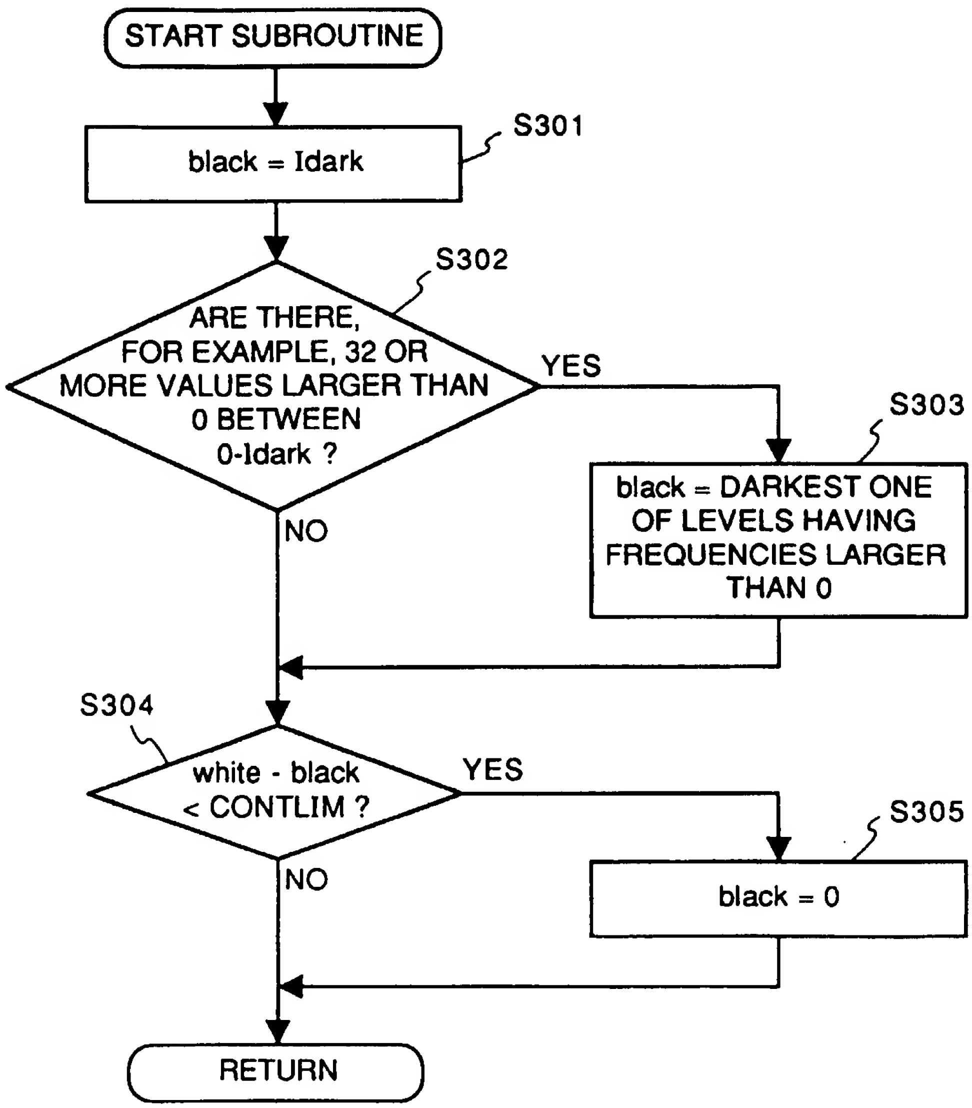

START SUBROUTINE
S301
black = Idark
S302
ARE THERE, FOR EXAMPLE, 32 OR MORE VALUES LARGER THAN 0 BETWEEN 0-Idark ?
YES
NO
S303
black = DARKEST ONE OF LEVELS HAVING FREQUENCIES LARGER THAN 0
S304
white - black < CONTLIM ?
YES
NO
S305
black = 0
RETURN

FIG. 22

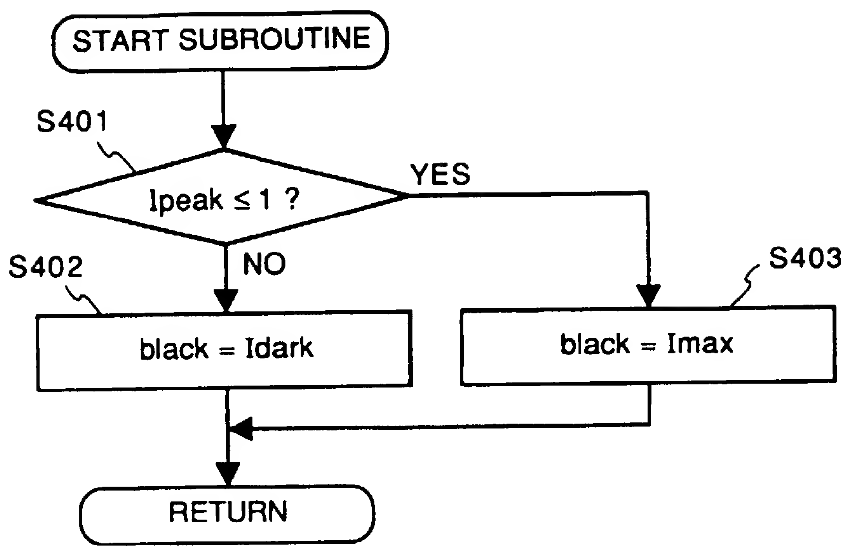

START SUBROUTINE
S401
Ipeak ≤ 1 ?
YES
NO
S402
S403
black = Idark
black = Imax
RETURN

FIG. 23

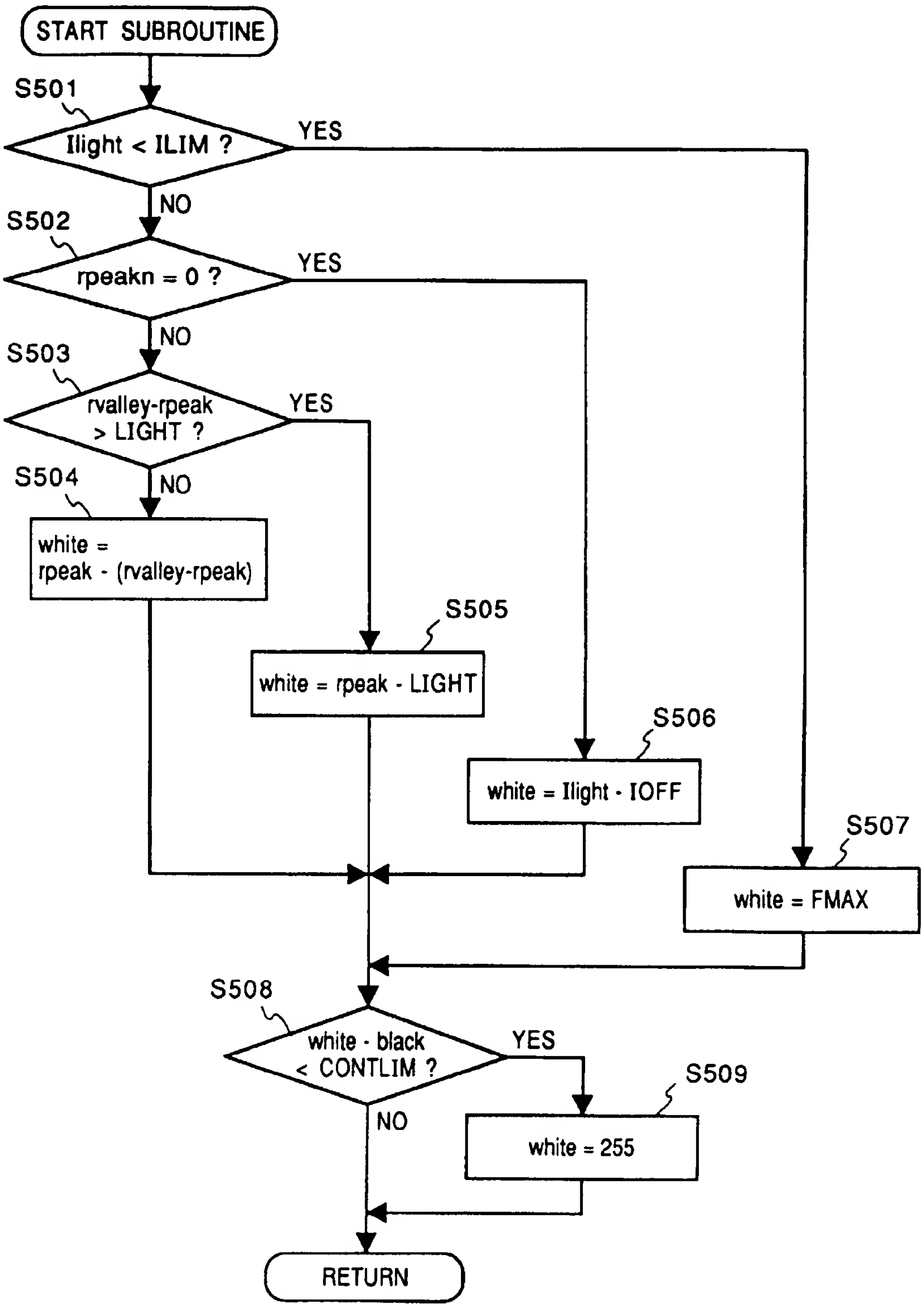
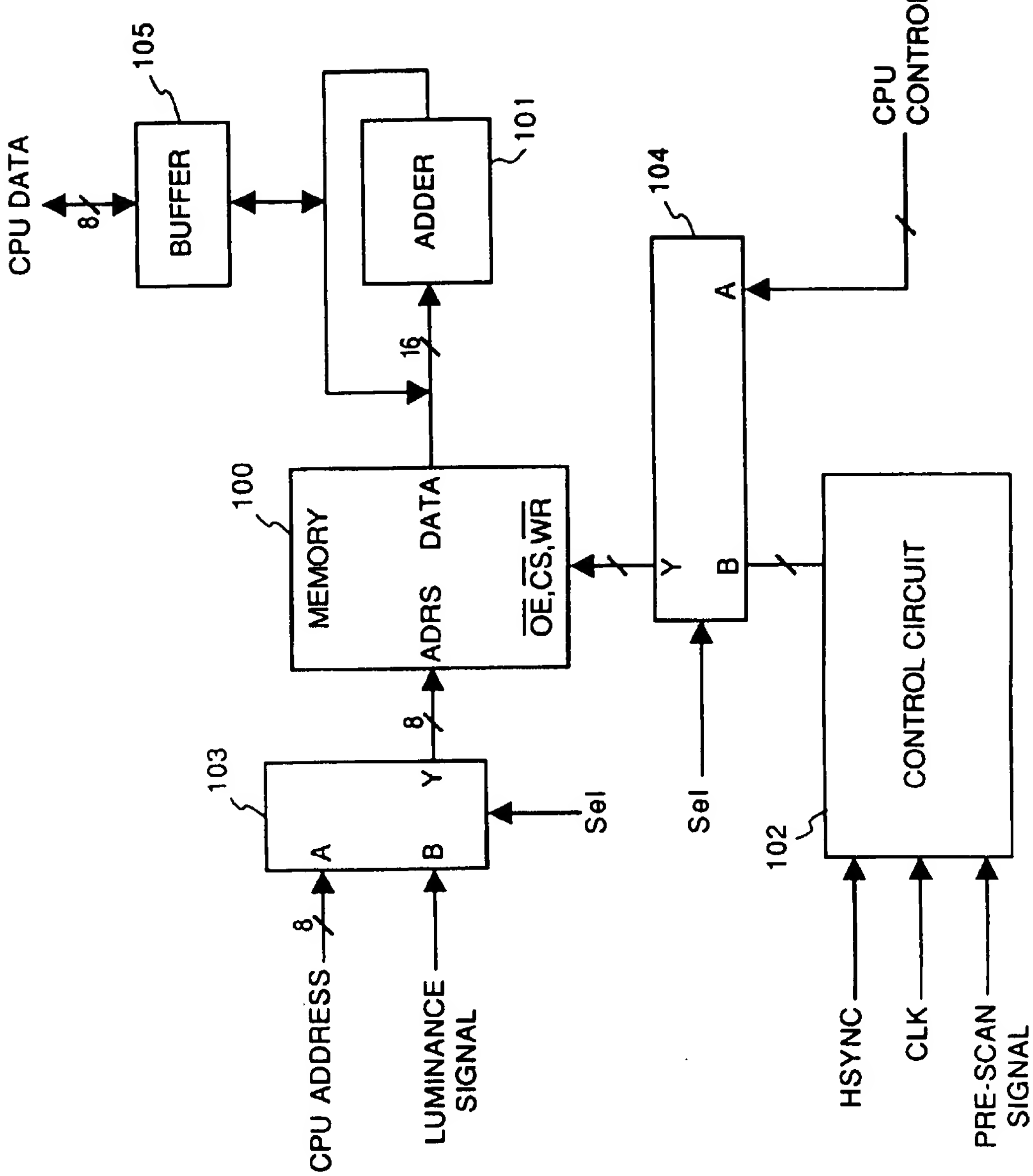

START SUBROUTINE
S501
Ilight < ILIM ?
YES
NO
S502
rpeakn = 0 ?
YES
NO
S503
rvalley-rpeak > LIGHT ?
YES
NO
S504
white = rpeak - (rvalley-rpeak)
S505
white = rpeak - LIGHT
S506
white = Ilight - IOFF
S507
white = FMAX
S508
white - black < CONTLIM ?
YES
NO
S509
white = 255
RETURN

FIG. 24



CPU DATA
8
BUFFER
105
ADDER
101
16
MEMORY
ADRS
DATA
$\overline{OE}$,$\overline{CS}$,$\overline{WR}$
100
103
A
B
Y
8
Sel
CPU ADDRESS
8
LUMINANCE SIGNAL
104
A
Y
B
Sel
CPU CONTROL SIGNAL
CONTROL CIRCUIT
102
HSYNC
CLK
PRE-SCAN SIGNAL

FIG. 25A

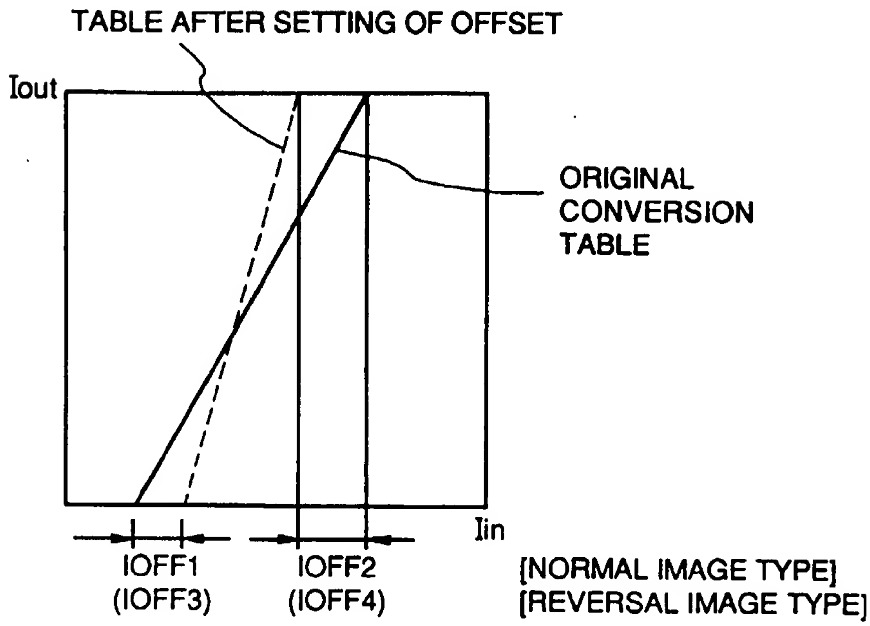


FIG. 25B